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Agricultural Experiment Station

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UNIVERSITY OF ILLINOIS,

Agricultural Experiment Station.

CHAMPAIGN, AUGUST, 1891.

BULLETIN NO. 17.

CONTENTS.

Experiments with Wheat, 1890–91.
Daily Variations in Milk and Butter Production of Cows.

EXPERIMENTS WITH WHEAT, 1890–91.

This article reports some of the results of experiments tried with wheat in the season 1890–91, with reference also to like experiments of previous years.

These experiments are reported:

No. 65. Quantity of seed.
No. 66. Time of sowing.
No. 67. Depth of sowing.
Nos. 62 and 69. Effect of fertilizers.
No. 116. Test of varieties.

The season of 1890–91 was more than usually favorable for wheat over most of Illinois, and the crop of the State was one of the best for many years. The experiments reported, except No. 69, were made on the fertile dark colored prairie soil of the Station grounds at Champaign. Experiments with fertilizers were made at Flora, Odin, Nashville, and near Belleville.

Trials for three years indicate that variations in quantity of seed between one and two bushels per acre have less effect on yield than other conditions. In 1891 the largest yield was from six pecks per acre; in 1890, from four and from eight pecks; in 1889, from five pecks.

In 1891 sowing small kernels gave a larger yield than was obtained from the same weight of larger kernels, but less than from the same number of larger kernels. The kernels in the crop from the small seed were approximately as large as those from the larger seed.

In two trials no injury resulted from rolling drilled wheat soon after sowing.

The yields of five plats, sown at intervals of ten or twelve days from Sept. 2d to Oct. 14th, were all good. It is not certain that they were affected by the date of sowing. If the last sown plats be excepted, there was no appreciable difference in time of ripening, and very little including it. The quantity of straw and the number of stalks per square foot decreased from the earliest to the latest sowing. The average length of heads and weight of kernels increased from the first to the last, except in the case of the second sowing, which was better than the third. In view of danger from the Hessian fly and of undue growth of straw, very early sowing is not advisable; and the danger to late sown wheat from repeated freezing in winter or early spring makes it unsafe in this latitude to sow in October.

Covering wheat one inch deep gave better results than covering three inches, and much better than covering five inches.

Trials with various commercial fertilizers on wheat indicate that on the soil of the Station grounds such use is not profitable. Barn-yard manure invariably produces a noticeable effect. Trials at Flora, Odin and Nashville show a marked increase in yield from use of barn-yard manure; those at Odin and Nashville, some increase from the use of superphosphate of lime, but, in general, not enough to make its use profitable. At Belleville neither barn-yard manure nor superphosphate produced any considerable percentage of increase in yield. At Flora the plats with superphosphate yielded less than those without any fertilizer. In view of the results in former years, trials on a small scale of superphosphate of lime and cattle tankage are recommended for wheat on the light colored soils of southern Illinois. The value of barn-yard manure for these soils can hardly be overestimated.

Trials of 12 varieties of English cross-bred wheat and of two varieties from France indicate possible value from some, with, however, a probability that all will mature too late to be very desirable in Illinois. A trial of a promising new variety of spring wheat from Canada, as was to have been expected, did not give promising results here.

Experiment No. 65. Wheat, Quantity of Seed.

This experiment has been tried for three years. The season of 1890-91 the same land was used as the preceding season. It was divided into seven plats each 2 x 4 rods. The land was plowed about Sept. 10th. It was harrowed twice and rolled Sept. 20th; and Sept. 22d the plats were sown with a drill at rates varying as closely as practicable from three to eight pecks per acre. The number of pounds of seed sown on each plat is stated in the table. Plat No. 5 was sown with small kernels, averaging 45 kernels per gram. The others were sown with well cleaned wheat of the same variety, averaging 27 kernels per gram. The attempt was made to sow the same number of kernels on plats 5 and 6, so that a comparison might be made of the effect of large and small seed. Plat No. 7 was rolled September 24th. The wheat was cut June 27, 1891, stacked July 8th, and threshed July 23d. The wheat was cut rather closer to the ground than in ordinary harvesting. July 1st, on each of the seven plats, the number of stubs was counted on two squares two feet on a side.

The table following gives the results:

AMOUNT OF SEED; YIELD OF WHEAT AND STRAW; NUMBER OF STUBS PER SQ. FT.

Plat.	Seed sown.		Yield per acre.		Weight 100 kernels, grams.	Stubs per sq. ft.
	Lb. per plat.	Pecks per acre.	Grain, bu.	Straw, lb.		
1	2.5	3	22	4,140	28.7	29
2	3.25	4	21.31	3,760	28.6	32
3	4	5	22.18	4,080	27.2	40
4	6	8	26.83	5,100	28	48
5	2.75	4	26	5,040	29.7	48
6	4.75	6	29	5,400	30.9	53
7	5	6	27.66	4,560	29.4	53

The following table from bulletin No. 11, p. 348, gives the results of the trials in two preceding years:

AMOUNT OF SEED, AND YIELD OF WHEAT AND STRAW.

Number of pecks sown per acre.	Yield per acre.			
	1888–9.		1889–90.	
	Grain, bu.	Straw, lb.	Grain, bu.	Straw, lb.
3	....	....	24.6	2,215
4	36.2	4,560	28.2	2,620
5	38.3	4,700	26.3	2,740
6*	36.3	4,750	24.5	2,200
8	35.4	4,540	28.3	2,740

*In 1889, a plat adjacent to this was drilled at the same rate and afterwards rolled. This plat yielded at the rate 26.5 bushels per acre.

In 1891 the two largest yields were from sowing at the rate of six pecks per acre; the next from sowing eight pecks; with nearly as much from sowing four pecks of smaller seed. The yields from sowings of three, four and five pecks per acre of good seed were less than when six or eight pecks were sown. In 1890 the largest yields were from sowings at rate of eight and four pecks; with best yield from sowing six pecks. In 1889 the largest yield was from sowing five pecks, with yields almost the same from sowings of four and six pecks.

In the fall of 1889 a plat was rolled after being sown and yielded a little more than the adjoining plat not rolled.

In 1890 a plat was rolled which yielded a little less than the adjoining plat unrolled, but under like conditions otherwise.

There was comparatively little difference in the weight of lots of 100 kernels from each of the plats. Those from the plats sown with small kernels were slightly heavier than those from any other plat, with one exception. The number of stalks per square foot was largest when six pecks per acre had been sown.

Experiment No. 66. Wheat, Time of Sowing.

In the trial for 1890-91 a tract of land was used which had been in oats in 1890, preceded by three crops of corn, and these by clover. The land was plowed at different dates from August 2d to 29th, but each plat sown had received like treatment as to plowing. The plowing was six inches deep, the land being rolled soon after plowing. The tract was divided into five plats two rods wide and a little over 51 rods long, containing .64 of an acre each.

The wheat was drilled at the rate of one and one-half bushels per acre, as nearly as practicable, each plat being disked twice, harrowed twice and rolled the day it was sown or the day previous. The rainfall had been light and the ground was rather dry. After the last plat was prepared for seeding there was a rainfall of .51 inch, and the wheat was sown on it the next day. The dates of sowing were September 2, 12 and 22, and October 2 and 14.

The growth in the autumn was not strong. The two plats first sown made the largest growth, but did not appear to have so uniform a stand as the third and fourth sowings. The latest sowing went into the winter with a small and feeble growth. The Hessian fly made its appearance on the earlier seeding, but did no appreciable injury. The winter was exceptionally mild and the spring unusually favorable for the wheat. The earlier sowings made a very good growth. The first sowing was tallest and had rather shorter heads than the later sown plats. Much of the wheat was five feet high. That last sown headed some days later than the others, but matured within a day or two of same date. There was no perceptible difference in the time of maturing of the other plats. There was 10 per cent or more of blasted or smutted heads. Aside from this, the plats attracted much favorable comment. Intelligent visitors could see no difference between the first four sowings. Large numbers of English sparrows did considerable damage before and after cutting; apparently most on the first sown plat, the injury decreasing in order of sowing.

The wheat was harvested June 29th and threshed July 7th. A little rain fell the night before threshing, making the wheat " tough " in threshing, and a little was left in the straw. The number of stalks on areas of 4 sq. ft. was counted in six places in each of the five plats. The aggregates for the 24 sq. ft. in each plat were: 1299, 1218, 991, 953 and 860, showing a steady decrease from earliest to latest sowing. In one place in the fourth sowing the number of stalks was less than half the average of the others in that plat; but for this the fourth plat would have shown more stalks than the third. The largest number per sq. ft. was 63. In only six of the 24 areas counted was the number per sq. ft. less than 35. These numbers do not indicate the number of heads. The number of stubs was also counted in a distance of 65 inches in two rows of each of the five plats. The averages of the two rows, from first to last sowings, were: 1067, 1018, 927, 897 and 840, showing a constant decrease in number.

The following table gives the results:

YIELD PER PLAT, LB.; YIELD PER ACRE, BU.; STUBS PER SQ. FT.

Plat.	Date of sowing.	Yield, lb.	Yield per acre, bu.	Stubs per sq. ft.
1	Sept. 2	1,186	30.88	54
2	Sept. 12	1,386	36.08	50
3	Sept. 22	1,324	34.46	41
4	Oct. 2	1,398	36.40	39
5	Oct. 14	1,310	34.11	36

All the yields were large for this region, the average being 34.6 bu. per acre. Especially with the uncertainty caused by injury by the birds, it is not safe to say that the yield was affected by the time of sowing. As reported in Bulletin No. 11 of this Station, the yields in 1889 from sowings at different dates were: September 22d, 38.2 bu.; September 29th, 40.4 bu.; October 8th, 36.1 bu. In 1890 the yields were: September 12th, 32.4 bushels; September 23d, 29.1 bu.; October 4th, 20.8 bu.; October 15th, 12.1 bu. In March, 1890, there were severe freezings which injured the later sown wheat more than the earlier sown. In each of the three years there was a decrease in the yield of straw from the earliest to the latest sowing.

An attempt was made to select the largest heads from each plat. Of these 50 from each plat were compared. It was found that the earliest sowing had slightly the shortest and lightest heads, with least number of kernels; the latest sowing made the best showing in these particulars. The average number of kernels per head was 43.

The table shows results from each plat.

COMPARISON OF FIFTY HEADS FROM EACH PLAT.

Plat.	Average length, in.	Number of kernels.	Weight of kernels, grams.	Weight of heads. grams.
1	3.67	2,023	64.2	85.9
2	3.72	2,182	67.2	90
3	3.69	2,141	65.2	87.6
4	3.78	2,189	65.7	88.5
5	3.96	2,364	73.6	99.8

Experiment No. 67. Wheat, Depth of Sowing.

September 27, 1890, in each of nine rows one rod long and one foot apart, 198 kernels of selected seed wheat were planted. This is one kernel for each inch. The wheat in rows 1, 2, 3 was covered one inch deep; that in rows 4, 5, and 6, three inches; that in rows 7, 8, and 9, five inches. An extra row was planted on each side.

June 30, 1891, the wheat was harvested. The stand was best on rows 1 to 3, good on rows 4 to 6, and poor on rows 7 to 9. The wheat was about four feet high. The yield is not reported, as the English sparrows had done some injury. There was, as in all the wheat on the Station grounds, a very perceptible percentage of smutted heads. The facts as to each row are given in the table.

Row.............	1	2	3	4	5	6	7	8	9
Total stalks.......	648	648	710	541	615	623	417	475	169
With good heads..	608	603	662	498	588	580	410	444	155
Without heads	16	3	4	12	4	10	0	2	10
Showing smut	24	42	44	31	23	33	7	29	4

The indications were that in this favorable season shallow covering was decidedly better than deep.

Experiment No. 62. Wheat, Effect of Fertilizers.

The trials made in 1889 and 1890 with commercial fertilizers of different kinds for wheat on the Station grounds did not indicate, with certainty, any appreciable effect from their use. In the fall of 1890 a trial was made to see if any effect would be produced upon wheat from fertilizers which had been applied in unusually large quantities in the spring of 1889. (Two crops of corn had been grown on the land without appreciable influence by the fertilizers.) Seven plats were used each 2 x 4 rods. The land was disked and harrowed twice, September 20, 1890, and the wheat drilled at the rate of about one and one-half bushels per acre, 34 lb. being sown on 56 square rods. The corn had been cut September 16th, and removed from the plats.

The table gives results.

Yields of Wheat in 1891 from Plats upon which had been put Commercial Fertilizers in large Amounts in 1889.

	Fertilizers applied in 1889 only.	Pounds per acre.	Grain per acre, bu	Straw per acre, lb.	Wt. 1,000 kernels, grams.
1	Dissolved bone-black... Sulphate of potash..... Sulphate of ammonia..	2,000 600 600	20.83	3,960	29.45
2	None..................	....	23.08	4,200	30.4
3	Dissolved bone-black...	2,000	23.33	3,840	30.5
4	None....	....	22.33	3,440	29.1
5	Sulphate of potash.....	600	18.16	2,800	29.5
6	None..................	....	25	4,160	30.1
7	Sulphate of ammonia ..	600	22.75	3,760	30.2

It will be noticed that the smallest yield of both grain and straw was from the plat to which sulphate of potash had been applied; the largest from one of the unfertilized plats. The average yield of the unfertilized plats was a little more than that of those on which the fertilizers had been applied. No sufficient reason appears for the small yield of plat No. 5, unless the fertilizer produced an unfavorable effect. The yields were noticeably smaller than those of the plats adjacent in which effect of time of sowing was tested. There was little difference in weight of the kernels.

The results of all the trials here with commercial fertilizers on wheat, as also on corn, do not show that it is generally profitable to apply these on the black prairie soils of central Illinois.

On the University farms the effect of a liberal application of stable manure made in 1888 was plainly seen in wheat of 1890–91 in a more vigorous growth of straw.

Experiment No. 69. Wheat, Effect of Fertilizers.

For three years past experiments with commercial fertilizers on wheat have been tried at points further south than the Station grounds. For 1890-91 the trials were made on the farms of W. W. Bowler, Flora; A. M. Woodward & Co., Odin; Chas. Stephani, Nashville, and Fred Helms, Wilderman, near Belleville. These are all not far from latitude 38° 30′, and, except the last named, on the level light colored soils, characteristic of that region. Mr. Helms's soil is darker colored and naturally very fertile.

The land at Mr. Bowler's had been in grass from 1883 to 1888. In 1889 it produced about 40 bushels of corn per acre. In 1890 it was sown to oats, but the crop failed. The land at Odin had been thrown out of cultivation for several years until 1889, when it produced a fair crop of corn. In 1890 it was sown to oats, which failed to produce a crop. The land at Nashville had been in cultivation about 40 years—in corn in 1883 and 1884; oats in 1885; wheat in 1886; oats in 1887; wheat in 1888 and 1889; and in oats in 1890. Mr. Helms's land has been cultivated by him 22 years without manure. It was in wheat on clover sod in 1889–90, and yielded about 30 bushels per acre.

In each case, except at Flora, nine plats 2 x 20 rods, containing one-fourth acre each, were used. To plat 1 in each case five wagon loads of barn-yard manure were applied, and 100 lbs. of glue factory superphosphate to plats 3, 4, 6, 7, and 9. On the farm of Mr. Bowler, near Flora, 9 additional plats of the same size were used, 50 lb. of superphosphate being applied to plats 10, 12, 13, 15 and 16. The barn-yard manure and superphosphate were applied before sowing.

In each case the land had the treatment usual in the region in preparing for wheat. The wheat was sown with a drill about September 20, 1890. The winter was favorable for the crop. When visited at the last of April, as well as at harvest time, the effect of the barn-yard manure in stimulating growth was very apparent; that of the superphosphate, less so. The wheat was carefully harvested, and threshed from the shock, except at Flora, where Mr. Bowler was compelled to put it in stack and thresh August 20th. Mr. Helms estimates that his crop was damaged one-fifth or more by plant lice. The wheat at Nashville was measured; at the other places, weighed. It was all of good quality.

The results are given in the table:

EFFECT OF FERTILIZERS UPON WHEAT, 1890–91.

No. of plat.....	1	3	4	6	7	9	Average.	2	5	8	Average.
	20 loads manure.	400 lbs. superphosphate per acre.						No fertilizer.			
	Yield per acre, bushels.										
Flora..........	25.47	18.2	20.2	15.2	19	16.53	17.83	20.07	20.93	18.13	19.71
Odin	25.47	17.93	19.2	20.66	20.06	21	19.85	19.33	20 06	19.53	19.64
Nashville	28	16	16	16	15	17	16	10	10	10	10
Belleville	40.7	40.23	40.01	39.05	39.8	39.16	39.85	35.25	36.9	37.8	36.65
Average	29.91						23.38				21.50

The average yields were good; that at Belleville especially so, notwithstanding the injury by plant lice. Compared with the unmanured plats, those to which superphosphate of lime was applied at the rate of 400 lbs. per acre show an increase of 1⅞ bushels per acre. The average increase at Nashville was six bushels; at Belleville over three bushels. At Odin there was only a very slight increase, while at Flora the unmanured plats gave a somewhat larger yield than those receiving superphosphate.

Compared with the unmanured plats, the plats receiving barn-yard manure at the rate of 20 ordinary two-horse wagon loads per acre showed an average increase of over 8⅜ bushels per acre. At Nashville the increase was 18 bushels—from 10 to 28 bushels; at Flora and Odin nearly 6 bushels, and at Belleville 4 bushels per acre.

The cost of the application of the superphosphate at Nashville was about repaid by the increased yield; at neither of the other places was this the case, while at Flora the yield was slightly lessened on the plats receiving this fertilizer.

The five plats at Flora each receiving superphosphate of lime at the rate of 200 lb. per acre gave yields at rate of 17.33, 16.8, 18.46, 14.60 and 17.33 bu., an average of 16.9 bu. per acre. The unfertilized plats gave yields at rate of 19.26, 16.86, 16.73 and 16.5 bu., an average of 17.33 bu. per acre. It cannot be said with confidence that this lighter application did either good or harm.

The results of all these trials are not encouraging as to the profitable

EXPLANATION OF THE DIAGRAM

The diagram shows the daily milk record of cow No. 1, and the variation in the weight and composition of the milk from day to day during the period of her lactation. It gives the reader an opportunity to see more at a glance than could be readily obtained from the mass of figures which it represents.

This cow was the most nervous and sensitive of any of the six cows included in this experiment. Her milk was the richest and most variable in composition. She calved Sept. 23, 1891. This record begins Oct. 6, 1891, and continues to Aug. 6, 1892, when the cow was dry.

Each perpendicular straight line represents one day. The date is given every fifth day at the top of the diagram.

Each horizontal straight line represents two tenths or one fifth of a pound, when it applies to the weight of milk, solids, butter fat, and solids not fat in the milk, twenty pounds when it applies to the weight of the cow, and two-tenths of one per cent when it applies to the per cent of solids, butter fat and solids not fat in the milk. Excepting in the weight of the cow, five horizontal straight lines equal one pound, or one per cent.

The broken lines are labeled and numbered on the left margin, and at different places on the diagram. The dates when a change of feed was made are indicated by the heavy perpendicular straight lines.

The daily food of the cow was as follows, the figures indicating pounds.

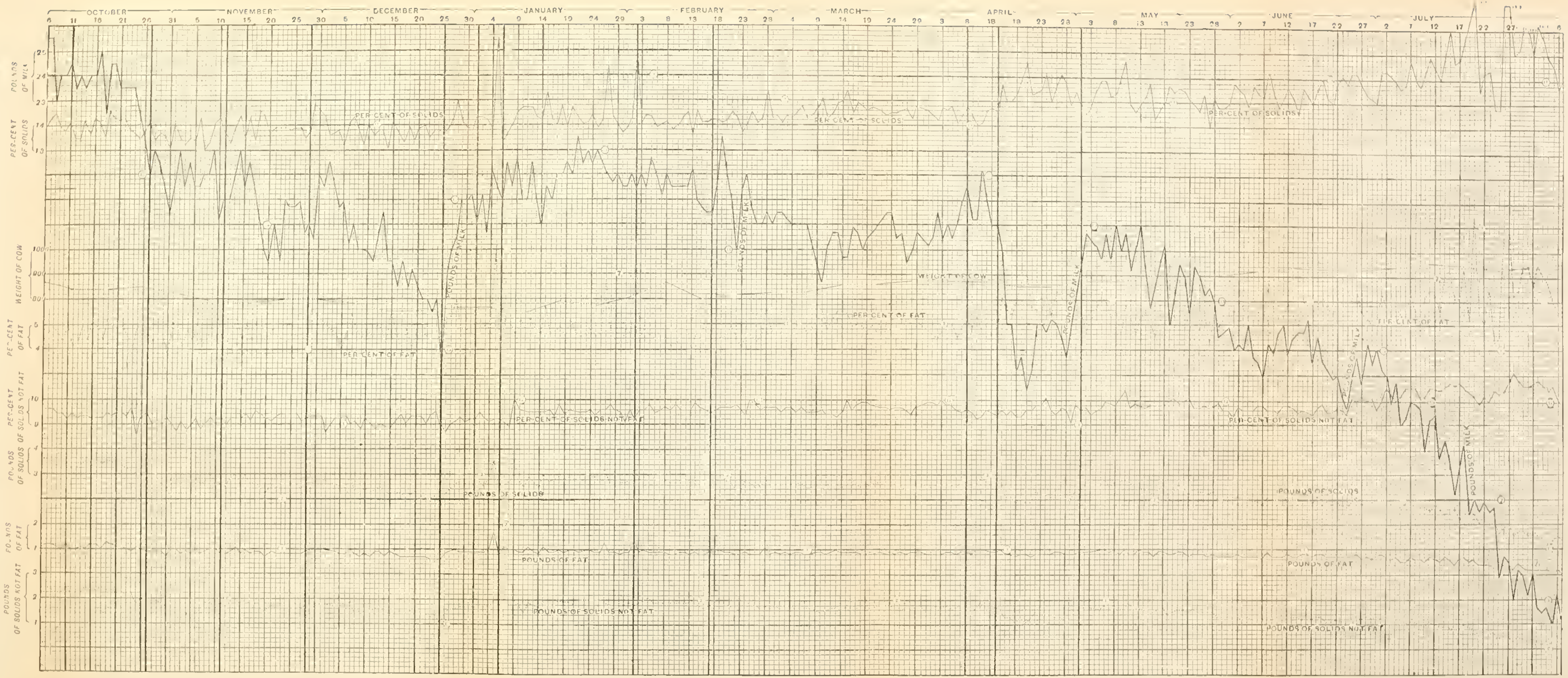
DAILY FOOD FOR PERIODS GIVEN

		Green corn fodder	Hay	Corn ensilage	Broken ear corn	Oil meal	Corn and cob meal	Wheat bran
Oct. 6–27	Pasture	30						
Oct. 27–Nov. 11			6		20	1		
Nov. 11–Dec. 25			6	30		2		
Dec. 25–Jan. 1			6	20		2	6	4
Jan. 1–Jan. 6	Straw stack		6			2	6	4
Jan. 6–Feb. 2	"		10			4	8	4
Feb. 2–17	"		12			5	10	5
Feb. 17–April 8	"		12			6	12	6
April 8–14	"		12			6	12	
April 14–30			22			6		
April 30–Aug. 6	Pasture only							

The influence of these changes of feed, on the quantity and quality of the milk are very clearly shown by the diagram. From Oct. 6th to Dec. 25th, the feed was not sufficient to keep up the flow of milk which gradually declined. When the feed was increased after Dec. 25th there was an increase in the milk produced, which was kept up until April 14th, when there was quite a sudden drop in the milk production caused by the change of feed. When pasture feeding began the flow of milk increased for a short time and the diagram shows the gradual decline in milk from that time until the cow was dry.

The lines which represent the composition of the milk from day to day, show that the butter fat is the constituent which is subject to the greatest variation. The per cent of solids not fat was quite uniform from day to day until about the last month of the milking period, when it increased, but not so much as the butter fat at the same time.

The weight of the cow each week is shown at the point where the solid and dotted lines change one from the other.



use of superphosphate of lime, or dissolved bone, for wheat on the light colored soils of southern Illinois. In view of the results in previous years, however, trials on a small scale are recommended, as also of cattle or hog tankage, at the rate of about 400 lbs. per acre. The very great value of barn-yard manure for these soils is well illustrated by these experiments, most noticeably at Nashville.

Experiment No. 116. Wheat, Test of Varieties.

Trials were made of very small quantities of 12 varieties of cross-bred wheats received from Carter's, of London, England. These wheats were exhibited at the Show of the Royal Agricultural Society of England at Windsor, in 1889, the parent stocks also being shown. They very favorably impressed the writer. The samples received were of fine appearance. They were sown September 27, 1890, in rows one foot apart. The results were not conclusive. It is probable that most, if not all, the varieties will mature too late to be very desirable here. Two or three may be considered promising. They will be tested further.

The U. S. Department of Agriculture sent the Station packages of two varieties of wheat labeled "Hybride Lamed" and "Hybride Dattel." The kernels were remarkably plump and attractive in appearance. Through a mistake of the postal authorities these wheats were not received until October 4th. They were sown October 8th, and made a fair growth and gave fair yields. They were a week or more later in maturing than the ordinary varieties. Positive judgment as to their value for this region is suspended until further trial.

A small package of Campbell's white chaff, described as a new spring variety originating in Simcoe Co., Ontario, was received from Canada and sown in rows in the spring. The quantity received was small. The English sparrow injured the ripened grain somewhat so that only general impressions can be reported. These were not favorable; but spring wheat growing has not been found generally profitable for this region, and perhaps, can not be fairly tested here.

G. E. MORROW, A.M., *Agriculturist.*

Daily Variation in the Milk and Butter Production of Cows.

The quantity of milk produced by a cow and the quality of the milk are influenced directly by the individuality, and indirectly by the breed of the animal. Each breed is only a group of individuals of the same kind. The breeds differ from each other by certain characteristics which are preserved so long as conditions are not sufficiently strong to change them. To the distinct characteristics belong the disposition to produce a large quantity of milk, or milk prossessing a specific peculiarity, such as high content of butter fat and casein.

Numerous observations show that with nearly all cows the milk production follows the general course of decreasing in quantity of milk and butter, and increasing in percentage of butter fat as the period of lactation progresses.

By weighing and testing the milk of cows every day, I have observed that lines representing the daily production of milk and of butter fat do not take the course of a straight line down an inclined plane, but are broken, zigzag lines. The results of these observations are given here in plates on pp. 12–15.

The days from May 1st to July 5th are represented by the perpendicular lines in the plates, every fifth day being numbered at the top.

The figures on the left of the plates represent:

First, per cents of butter fat in the milk produced each day, the horizontal lines representing successively an increase of .2 or 1-5 of one per cent.

Second, pounds of milk produced each day, each horizontal line showing successively an increase of .2 or 1-5 of one pound.

Third, the pounds of butter fat produced each day, calculated by multiplying the pounds of milk by the per cent of butter fat found in the milk for that day. Except for cow No. 5, the horizontal lines represent successively an increase of .04 or 1-25 of one pound of butter fat; for No. 5, they represent .02 of 1-50 of a pound.

The intersections of the broken and perpendicular lines show the point where the figures in the left hand margin are to be sought.

The dotted line on plate 1, represents the night milk, and the solid broken line on the same plate, the morning milk of cow No. 2.

There still remains a considerable amount of this material which cannot be printed for lack of space. The milk from each of five cows has been weighed and tested every day since May 27th. A diagram of the production of a cow during the whole period of lactation would be very instructive. So far as is known, this is the first time the suggestion has been made. We shall continue the diagrams.

The plates given here are an illustration only of the idea, and it is hoped that by these diagrams the reader is given an opportunity to see more at a glance than could be readily obtained from the mass of figures which they represent.

The history of these cows is given on page 511, bulletin No. 16, of this Station.

Cow No. 2 is a very nervous and somewhat vicious animal, while cow No. 5 is a mild-eyed, "mulley cow."

The broken lines of the diagram show the production of the cows from day to day, and are evidence to illustrate, *First*, that the variation in the quantity and quality of the milk of one cow at each milking is greater than the variation in the same cow's milk each day: compare plate 1 with plate 2.

Second, that under exactly the same conditions the daily milk of one cow varies more than that of another: compare plates 2 and 3.

Third, that the mixed milk of three cows is more uniform in amount and richness from one day to another than the milk of one cow.

The record of each milking of cow No. 2 (plate 1) shows the general tendency to equalize the milk production by going to both extremes. May 19th she gave 12.75 lb. milk in the morning and 7 lb. at night. The morning milk contained 6.5 per cent of butter fat, the night milk only 2 per cent. The average per milking of this cow for three months has been 9.35 lb. milk and 3.92 per cent of fat. For instance: in general, it can be seen that in this record when one milking was above the average in quantity and quality, the next milking went below, and *vice versa.*

During the 66 days represented in plate 2, the daily quantity of milk (from both milkings) varied from 23 to 17 lb.; the per cent of butter fat in the daily milk from 3 to 6.1, and the pounds of butter fat in the daily milk from 0.56 to 1.29.

The daily record of cow No .5 for the 66 days shows a very uniform per cent of butter fat, varying only from 2.8 to 3.4. The same regularity is seen in the total daily production of butter fat, 0.65 to 0.42 lb.; and plate 3 shows that the course of the line representing the pounds of of butter fat gradually declines from May 1st to July 5th. A decrease in the pounds of milk from day to day is also shown in the record of this cow.

Cow No. 2 is a striking example of occasional extreme variations in milk production, and, contrary to the general statement, the variation in quantity and quality coincide. That is, when she gave a small mess of milk it had a per cent of butter fat below her average, and the largest milkings were of her richest milk. This does not hold true in the average per cow calculated from the daily records of three cows, for the reason that the milk of cow No. 1 (not given here for lack of space) showed just the opposite tendency from cow No. 2. Nearly every time when the milk of cow No. 1 increased in quantity it decreased in percentage of butter fat; and as the pounds of milk per day decreased, the per cent of fat in the milk increased.

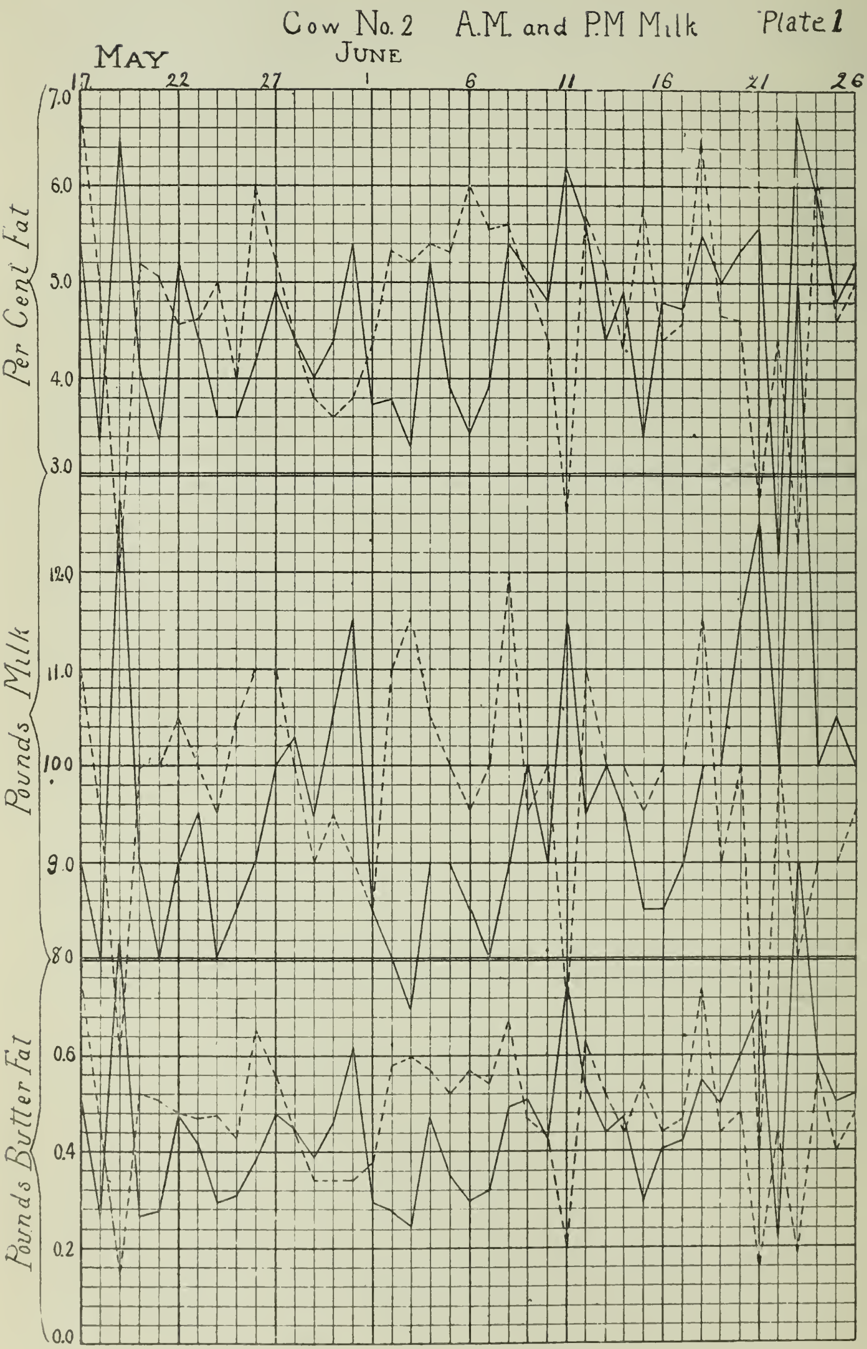
The record of cow No. 5 on this point shows a very uniform percentage of butter fat from day to day regardless of the quantity of milk produced.

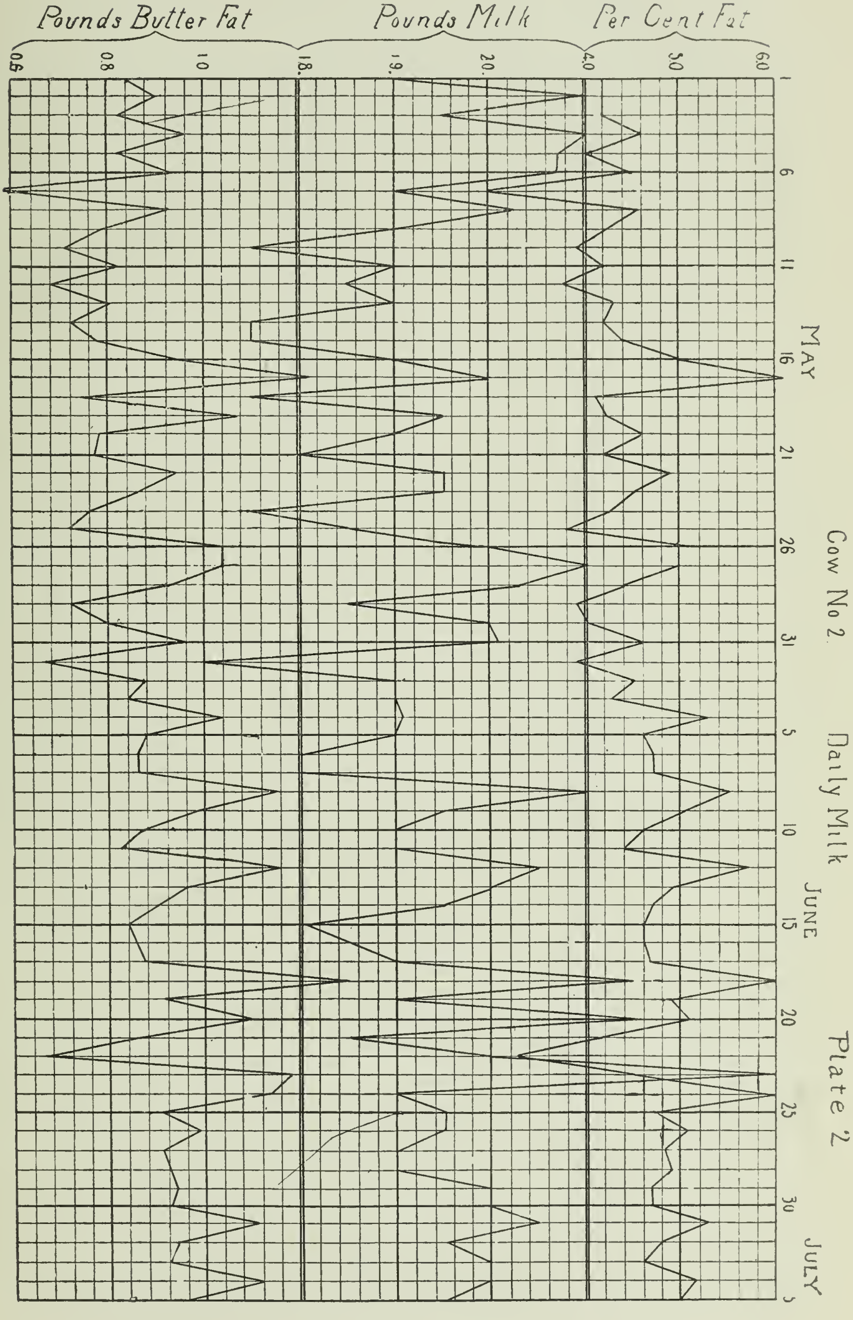
These individual characteristics may be more concisely stated thus—

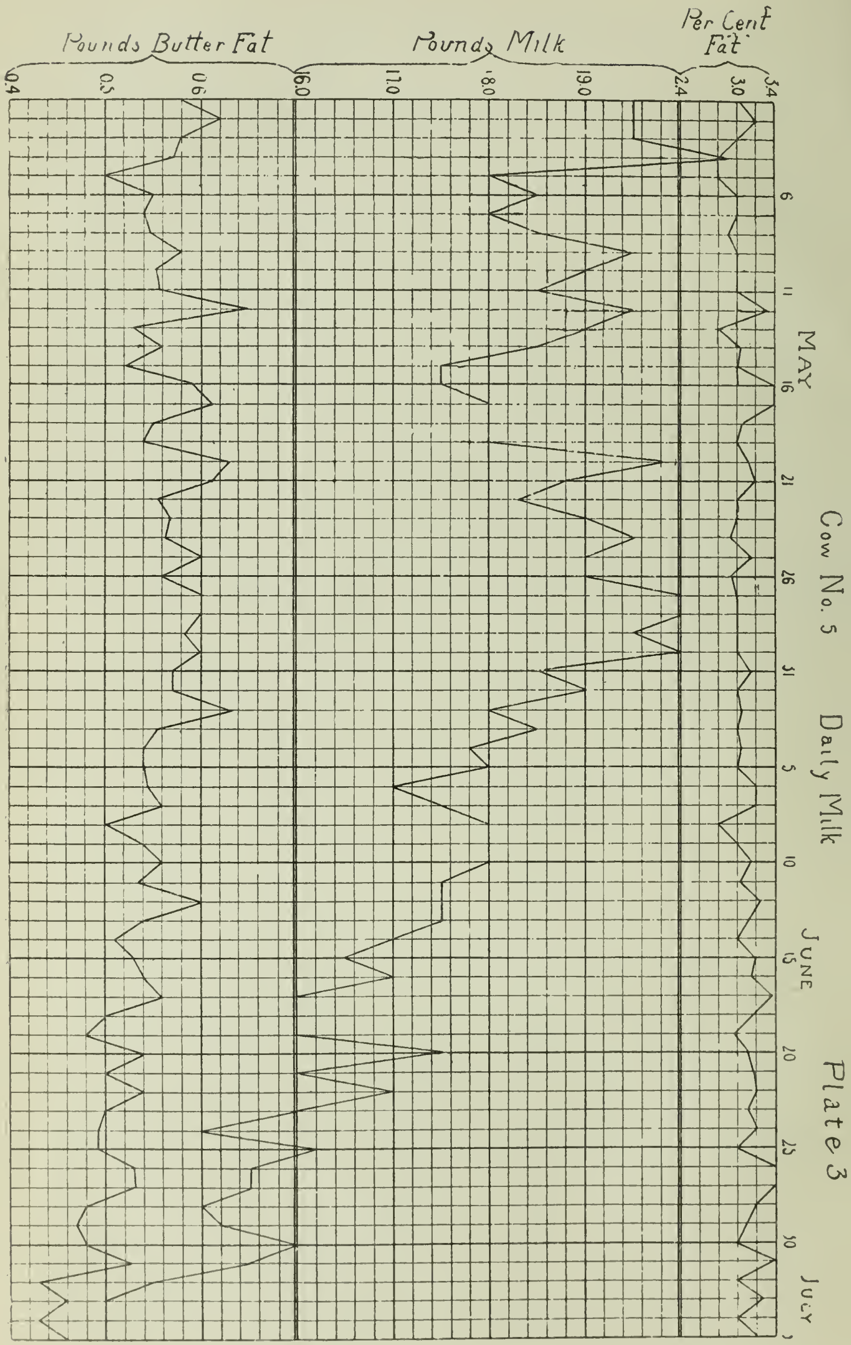
Cow No. 1. The richest milk is given when the quantity is small. The quantity decreased somewhat.

Cow No. 2. The richest milk is given when the quantity is large. The quantity did not permanently decrease.

Cow No. 5. The richness of her milk was very uniform and changed but slightly. The quantity decreased permanently.

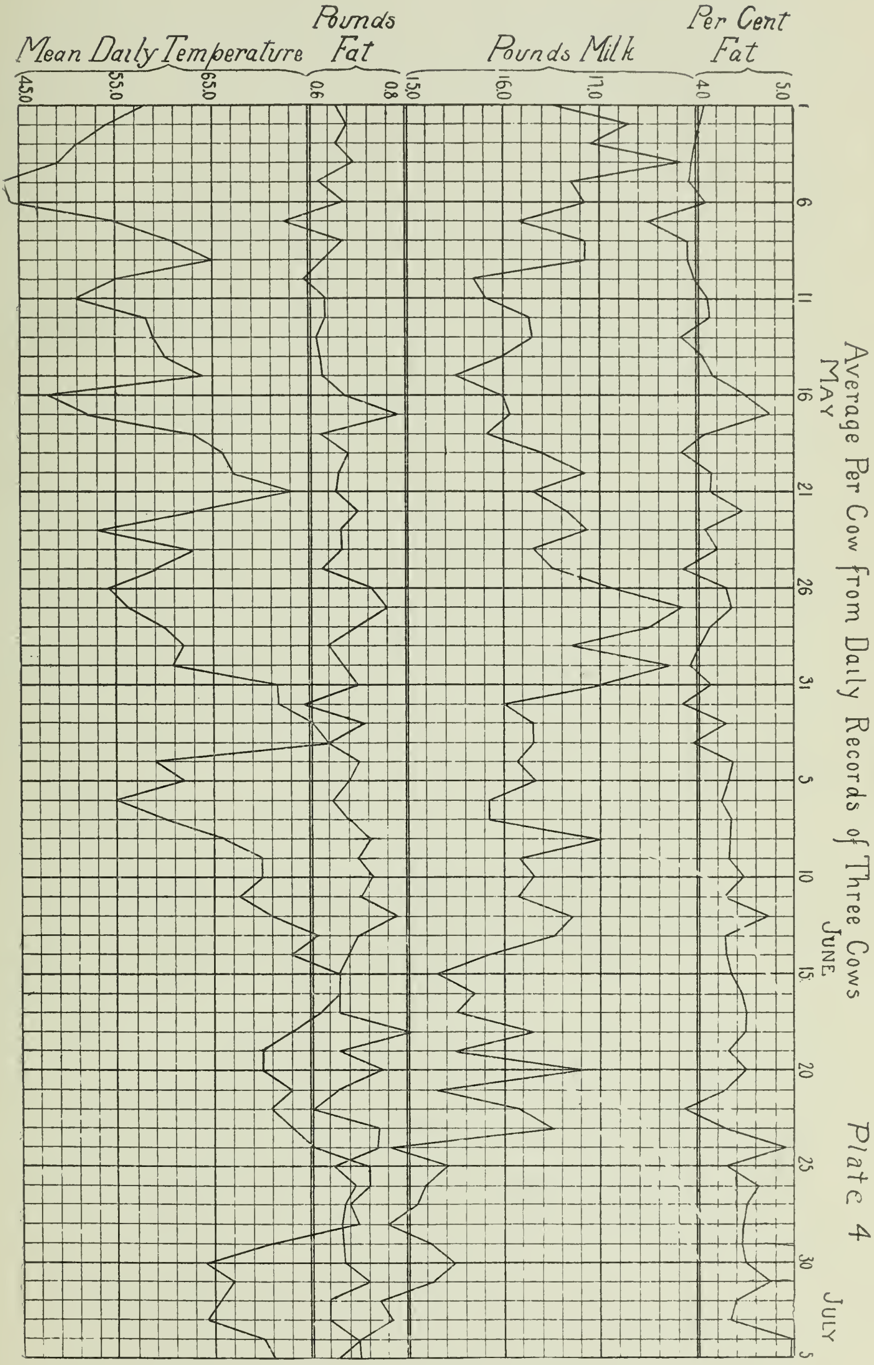

Cow No. 2 A.M. and P.M Milk
Plate 1
MAY
JUNE
17
22
27
1
6
11
16
21
26
Per Cent Fat
7.0
6.0
5.0
4.0
3.0
Pounds Milk
12.0
11.0
10.0
9.0
8.0
Pounds Butter Fat
0.6
0.4
0.2
0.0


Pounds Butter Fat
Pounds Milk
Per Cent Fat
0.6
0.8
1.0
18.
19.
20.
4.0
5.0
6.0
1
6
11
16
21
26
31
5
10
15
20
25
30
5
MAY
JUNE
JULY
Cow No 2.
Daily Milk
Plate 2



Cow No. 5 Daily Milk

Plate 3



Average Per Cow from Daily Records of Three Cows

Plate 4

Beginning June 18th, cow No. 2 was given 5 lb. of wheat bran daily; one week later this was increased to 7 lb. per day. The other two cows got nothing but pasture feed, which gradually grew very short in July on account of the severe drought.

By comparing plates 2 and 4 it can be seen that the upper three broken lines across plate 4 are not so irregular as the three lines across plate 2. This makes it very probable that the greater the number of cows in a dairy is the more uniform will be the production from day to day.

During the time of this record, May 1st, to July 5th, these cows have been exposed to uniformly dry whether. The rainfall for the month of May was .89 in.; June, 2.18 in.; total, 3.07 inches. The average of 10 years for these two months is 9.5 inches.

It is also of some interest to compare the line representing the daily pounds of milk shown in plate 4 with one showing the mean daily temperature.

Although there are exceptions, this comparison shows that as a rule the number of pounds of milk was low when the mean daily temperature was high, and the number was high when the temperature was low. In other words, these two lines give something of the appearance of an irregular picket fence with each picket sharpened at both ends.

The following table shows the highest, lowest, and average *daily* yield of milk, per cent of butter fat and pounds of butter fat produced by each of six cows from May 1 to August 1, 1891.

Also the average daily record per cow calculated from the total daily production of the whole herd.

YIELD OF MILK; PER CENT. OF BUTTER FAT; YIELD OF BUTTER.

No. of cow and period of milking after May 1st.	Pounds of milk.			Per cent of butter fat.			Pounds of butter fat.		
	Daily yield.			Daily yield.			Daily yield.		
	Highest.	Lowest.	Average.	Highest.	Lowest.	Average.	Highest.	Lowest.	Average.
No. 1, to July 27,	13	5.5	10.3	8	4.25	5.28	.666	.312	.539
No. 2, to August 1,	23	15	18.7	6 45	3	4.7	1.297	.574	.885
No. 3, to July 1,	11	4	7.9	4.8	2.9	3.56	.369	.16	.28
No. 4, to August 1,	45	25.5	38.2	3.95	1.7	2.99	1.71	.603	1.141
No. 5, to August 1,	20.5	10	15.9	3.6	2.8	3.14	.653	.33	.498
No. 6, July 6 to Aug. 1	26.5	20.5	24	4.4	2.7	3.31	1.166	.623	.792
Average for the herd,	22	16.6	19.44	4.58	3.26	3.92	.858	.483	.707

This table as well as the diagrams show that the test of a cow's milk for one day only may give a decidedly wrong impression of the cow's capacity for a week, month, or year.

E. H. FARRINGTON, M.S., *Chemist.*

UNIVERSITY OF ILLINOIS,

Agricultural Experiment Station.

CHAMPAIGN, NOVEMBER, 1891.

BULLETIN NO. 18.

DAIRYING EXPERIMENTS.

This bulletin contains reports as follows:

1. Tests of dairy cows at the Illinois State Fair, Peoria, and the American Dairy Show, Chicago, 1891.

2. Experiment No. 106. Investigations of Milk Tests.
    [*a*] Comparison of Babcock Test with the churn at the American Dairy Show and at the Station.
    [*b*] A device for measuring the acid used with the Babcock Test.
    [*c*] A method of marking milk test bottles.

3. Experiment No. 122. Composite Milk Samples Tested for Butter Fat. (Continuation of report in B. 16.)

4. Experiment No. 131. Cream Separation. Test of Methods.
    Observations on the per cent of butter fat in skim-milk when milk has been set in cans at different depths; also per cent of butter fat in the skim-milk at the bottom, middle and top of the cans.

5. Experiment No. 115. Cream Raising by Dilution.
    Observations on the rate at which cream rises when the milk has been diluted with water; and as to whether the rising of the cream is hastened by the reduction in temperature or by the dilution of the milk.

STATE FAIR TEST.

The Illinois State Board of Agriculture offered prizes for cows whose milk should be tested at the State Fair at Peoria, Sept. 28 to Oct. 2, 1891, and at the Dairy Show in Chicago, Nov. 11 to 21, 1891. At the request of the Board, through Mr. S. W. Johns, superintendent of the dairy cattle classes, the milk was tested by the chemist of this Station.

At the State Fair the competition was for first and second prizes to cows over three years old, and for like prizes to those under three years old in each of the following breeds: Ayrshire, Holstein-Friesian, Jersey, and Shorthorn; also for a sweepstakes premium to the cow exceeding all others in the test. The prizes were awarded to cows producing the most butter fat in the one day's test, made Sept. 29th. The Shorthorn cows were tested for two days in accordance with requirement of the American Shorthorn Breeders' Association, which offered a special prize for cows of that breed.

The table on pp. 20 and 21 gives the results. In each class the cows are given in order of production of butter fat. The weights of the cows are estimates made in most cases by their owners.

No very striking variation in the composition of the milk given by any one cow at different milkings is shown. Some cows gave the richest milk at night, some in the morning. Generally the cows which were milked three times each day gave the richest milk at noon.

It is well known that a short test at a fair may not show the average capacity of the cow.

AMERICAN DAIRY SHOW TEST.

For the Dairy Show, in connection with the Fat Stock Show, the test was required to be for three days. Three cows only competed; two Brown Swiss and one Devon. The cows were weighed the day before the test began. The Brown Swiss cows were also weighed the day after the test closed. The cow Brienz was 20 lb. heavier, and the cow Eliza 20 lb. lighter at the second weighing than at the first.

Mr. Bourquin states that the daily ration of each of the Brown Swiss cows, during the test, was about as follows: 24 lb. mixed grain, made of three parts corn and cob meal, one part ground oats and one part bran; 3 quarts cotton seed meal; 3 quarts linseed meal; 3 pecks carrots. This was fed in three equal feeds daily, with clover hay after each feed. The cows were offered water three times daily.

The results of the test are given in the table on p. 19.

The performance by the Swiss cow, Brienz, is a remarkable one, both as to milk and butter fat produced. It is not known that it has been equalled in either respect by any other cow tested at a public show.

The cows were kept in open stalls, exposed to the sight and handling of visitors. The weather was somewhat unfavorable.

RECORD OF COWS ENTERED FOR THE MILK TEST, AMERICAN DAIRY SHOW, CHICAGO, 1891.

	Milk,	Butter fat.		Milk,	Butter fat.		Milk,	Butter fat.		Total pounds of			Total pounds produced.			
													Per 100 lbs. of wt. of cow.		Per hour.	
	lb.	Per ct.	lb.	lb.	Per ct.	lb.	lb.	Per ct.	lb.	Milk.	Butter fat.	Butter containing 80 per ct. fat.	Milk.	Butter fat.	Milk.	Butter fat.
	Morning, 6 a. m.			Noon, 2:30 p. m.			Night, 9 p. m.									
Brown Swiss Cow, Brienz; 11 years old; weight 1,395 lbs.; last calf Oct. 10, 1891. Owner, A. Bourquin, Nokomis, Ill.																
1st day.............	30	3.3	0.99	29	4.3	1.247	22.5	4.5	1.01	81.5	3.25	4.06	5.8	0.23	3.4	0.13
2d day.............	29	3	0.87	29	4.1	1.189	22.5	4.3	0.967	80.5	3.03	3.8	5.77	0 217	3.3	0.126
3d day.............	30	2.8	0.84	29.75	4.1	1 219	23.25	4.2	0 976	83	3.04	3 8	5.95	0.218	3.46	0.127
Total	89		2.70	87.75		3.655	68.25		2.953	245	9.32	11.66				
Average...........	29.7	3.03	0.90	29.25	4.17	1.218	22.75	4.33	0.984	81.7	3.11	3.95	5.84	0.222	3.39	0.128
Brown Swiss Cow, Eliza; 10¾ years old; weight, 1360 lbs.; last calf Oct. 15, 1891. Owner, A. Bourquin, Nokomis, Ill.																
1st day.............	25	3	0.75	23	3.4	0.782	20	3.8	0.76	68	2.29	2.86	5	0.17	2.8	0.095
2d day.............	24	2.8	0.672	23	3.4	0.782	18	3.5	0.63	65	2.08	2.6	4.8	0.15	2.7	0.086
3d day.............	24	2.7	0.648	21.25	4.2	0.890	17	4	0.68	62.25	2.22	2.78	4.6	0.16	2.6	0.092
Total	73		2.070	67.25		2.454	55		2.07	195.25	6.59	8.24				
Average...........	24.3	2.83	0.69	22.41	3.67	0.818	18.3	3.77	0.69	65.08	2.2	2.74	4.8	0.16	2.7	0.091
Devon Cow, Jean; 4 years old; weight, 1002 lbs.; last calf, October 1, 1891. Owner, John Hudson, Moweaqua, Ill.																
							Night, 6 p. m.									
1st day.............	14	4.1	0.574	......	......	......	12	4.3	0.576	26	1.09	1.36	2.6	0.11	1.08	0.045
2d day.............	12	4.3	0.516	......	......	......	8	4	0.320	20	0.84	1.05	2	0.08	0.83	0.035
3d day.	9.5	4.6	0.437	......	......	.....	9.75	4.5	0.438	19.25	0.88	1.1	1.9	0.088	0.80	0.037
Total	35.5		1.527	..	...	......	29.75		1.274	65.25	2.81	3.56				
Average...........	11.8	4.27	0.509	......	......	......	9.92	4.27	0.425	21.75	0.94	1.18	2.17	0.092	0.903	0.039

RECORD OF COWS ENTERED FOR THE MILK TEST, ILLINOIS STATE FAIR, PEORIA, 1891.

Name.	Owner.	Age, years.	Last calf.	Approximate weight.	Pounds of milk.			Per cent butter fat in milk.			Total lb. for the day, 24 h.,		Pounds produced per 100 lb. of cow, approximate.	
					Morning.	Noon.	Night.	Morning.	Noon.	Night.	Milk.	Butter fat.	Milk.	Butter fat
Holstein-Friesian cows over 3 years old.														
Tirannia....................	J. H. Packard, New Windsor, Col.	8	Aug.	1,425	29.5	17.75	15.5	2.7	4.6	4	62.75	2.23	4.4	0.157
Empress Josephine.........	C. F. Stone, Peabody, Kas.........	6	Aug.	1,500	27	14	13.5	2.7	4.05	3.2	54,5	1.73	3.6	0.116
Rijaneta	Gillett & Son, Rosendale, Wis	11	Aug.	1,300	20.5	9	9.5	1 7	2.2	1.8	39	0 71	3	0.055
Holstein-Friesian cows under 3 years old.														
Mechtchilde, 3d...........	J. H. Packard, New Windsor, Col..	2	July	1,220	23.5	11	11.75	2.8	3.5	2.8	46.25	1.37	3.8	0.112
Vizzer Queen	W. H. Logan & Son, Seaton, Ill....	2	July	900	15	7	6.5	2.85	3.3	3.6	28.5	0.89	3.2	0.099
Duchess of Springdale, 4th ..	Gillett & Sons, Rosendale, Wis....	2	July	900	15	6	5	2.4	3.1	2	26	0.64	2.9	0.071
Pride of Winnikee..........	G. A. Stanton, Greenwood, Ind....	2	Aug.	900	14	....	14	1	....	1.3	28	0.32	3.1	0.036
Jersey cows over 3 years old.														
Buttercup Gem.............	George Merna, Wyoming, Ill......	5	Aug.	800	13	....	13.75	5.6	....	6	26.75	1.55	3.3	0.194
Edith Matin.................	George Merna, Wyoming, Ill......	6	Aug.	800	15.5	....	14	5	....	4.8	29.5	1.44	3.6	0.18
Kansas Cinderella...........	La Veta Cattle Co., Topeka, Kan...	4	July	800	13.5	....	14	5.3	....	4.8	27.5	1.38	3 4	0.172
Debbie's Pogis Darling......	Garretson Bros., Pendleton, Ind....	4	Aug.	800	14	....	13	5.3	....	4.6	27	1.34	3 4	0.168
Gossamer Signal...........	Latimer & Miller, Abingdon, Ill....	3	Aug.	800	14	....	13.5	5	....	4.3	27.5	1.28	3.4	0.16
Edithiro	George Merna, Wyoming Ill.......	5	April	800	10	....	8	6.3	....	6.2	18	1.12	2.2	0.14
Rosetta of Whiteland.......	La Veta Cattle Co., Topeka, Kan...	16	Sept	1,000	12.75	....	11	4.1	....	4.6	23.75	1.02	2.3	0.102
Brunette Star	C. Easthope, Niles, O............	7	Aug.	1,000	12	....	12 25	4.4	....	3.4	24.25	0.94	2.4	0.094

Jersey cows under 3 years old.														
Koffee's Champion Belle....	Latimer & Miller, Abingdon, Ill....	2	Aug.	700	12 5	.....	12	4.2	....	4.3	24.5	1.04	3.5	0.149
Perfection..................	La Veta Cattle Co., Topeka, Kan...	2	May	700	10	.....	11	4.7	....	4.4	21	0 95	3	0.136
Howland's Signal Era.......	C. Easthope, Niles, O............	2	July	700	10.5	.....	11	4.6	....	4.1	21.5	0.93	3	0.133
Nixie's Signal..............	Latimer & Miller, Abingdon, Ill....	2	July	700	10.	.....	10.5	4	....	4.3	20.5	0.85	3	0.121
Comassie La Veta...........	La Veta Cattle Co................	2	Aug.	700	6	.....	7	5	....	3.5	13	0.54	1.9	0.08
Ayrshire cows over 3 years old.														
Lady Jewess................	J. P. Beatty, Pataskala, O.........	8	....	900	15.5	.....	14	3.4	....	3.2	29.5	0.97	3 2	0.107
Pet Rose...................	R. J. & W. J. Munce, Clockeyville, Pa	6	July	900	13	.....	15.5	3.2	....	3.3	28.5	0.92	3.1	0.102
Braw Lass..................	R. M. Carrons, Washington, Pa....	5	July	900	10.5	.....	9.75	3.6	....	4.4	20.25	0.79	2.3	0.09
Ayrshire cows under 3 years old.														
Nellie Lisle................	J. P. Beatty, Pataskala, O.........	2	....	700	12	.....	10.5	4 7	....	4.1	22.5	0.99	3.2	0.141
Granny Pender.............	R. J. & W. J. Munce, Clockeyville, Pa	2	April	700	6	.....	6.5	4	....	3.9	12.5	0.49	1.8	0.07
Clyde......................	R. M. Carrons, Washington, Pa....	2	July	700	8	.....	8.5	2.8	....	2.6	16.5	0.44	2.3	0.06
Shorthorn cows over 3 years old.														
Arabella....................	J. Henn & Son, Redmon, Ill.......	3	First day		8	.....	8.5	3.9	....	4	16.5	0.65	......	......
			2d day		9	.....	8.25	4.2	....	3.9	17.25	0.69	......	......
Doodle.....................	J. Henn & Son, Redmon, Ill.......	4	First day		5.5	.....	5.5	3.6	....	3.8	11	0.4	......	......
			2d day		5.75	.....	6	3.6	....	4	11.75	0.44	......	......
Summary—Averages from the above Record.														
Holstein-Friesian cows over 3 years old........					25.7	13.6	12.8	2.3	3.6	3	52	1.55	3.7	0.109
Holstein-Friesian cows under 3 years old.......					17	8	9.3	2.2	3.3	2.4	32.2	0.8	3.2	0.08
Jersey cows over 3 years old..................					13	.....	12	5.1	....	4.8	25.5	1.28	3	0.152
Jersey cows under 3 years old.................					9.8	.....	10.3	4.5	....	4.1	20.1	0.86	2.9	0.124
Ayrshire cows over 3 years old................					13	.....	13	3.4	....	3.6	26	0 89	2.9	0 09
Ayrshire cows under 3 years old...............					8.7	.....	8.5	3.8	....	3.5	17.2	0.64	2.4	0 09
Shorthorn cows over 3 years old...............					7	.....	7	3.8	....	3.9	14.1	0.54	.....	.....

Experiment No. 106. Investigation of Milk Tests.

COMPARISON OF BABCOCK TEST WITH THE CHURN AT THE AMERICAN DAIRY SHOW AND AT THE STATION.

The milk given at one milking at 2:30 p. m., November 18th, by the two Brown Swiss cows tested at the Dairy Show at Chicago was taken for churning. The milk weighed 52 lb. and by test contained 1.971 lb. butter fat. It was run through a "Baby" hand separator No. 2. Several samples of the skim-milk were taken as it came from the separator, which showed only a trace of butter fat. The cream weighed 10.25 lb., or 19.7 per cent of the new milk. The tests showed that the cream contained 19.23 per cent butter fat. This cream was ripened for about 24 hours and then churned. The details of the results are given in the table below.

During the progress of the Dairy Show a working dairy was in operation. For this thirty cans of milk were received. Wednesday, Nov. 18, this milk weighed 2,035.25 lb. It was put in a large vat, warmed, and thoroughly mixed. The thoroughness of the mixing is illustrated by the fact that tests of four samples showed no variation in

RESULTS OBTAINED FROM THE CHURNINGS.

	Cream from milk of	
	Brown Swiss cows.	Working dairy
Weight of cream churned	10.25	....
Temperature of cream churned	61° F.	61° F.
Temperature of buttermilk	59° F.	61° F.
Time of churning	65 min.	17 min.
Acidity of cream [50 c.c.=1-10 normal alkali]	25.5 c.c.	37 c.c.
Weight of buttermilk, lb	15	204.5
Per cent of fat in buttermilk	0.6	0.3
Weight of salted butter from churn, lb	2.1875	104.5
Weight of butter fat by test of milk, lb	1.971	84.46
Difference	0.2165	20.04
Percentage increase of churn over test, or of butter over butter fat in the milk	11.5	23.6
Analysis of butter—		
Water, per cent	15.4	14.15
Butter fat, per cent	77.24	82.
Salt, per cent	6.6	3.
Curd, per cent	0.76	0.85
Total	100.00	100.00
Pounds of butter fat in the butter	1.689	85.69
Pounds of butter fat in the buttermilk	0.09	0.61
Total	1.779	86.30
Pounds of butter fat in the milk used, as shown by test	1.971	84.46
Difference—loss or gain in the process	—0.192	+1.84
Per cent which loss or gain was of total butter fat in milk used	—9.7	+2.17

the per cent of butter fat. One sample was taken from the middle of the vat, two from the ends, and one from the first milk drawn from the faucet. The milk contained 4.15 per cent of butter fat, or 84.45 lb. in the 2,035.25 lb. milk.

This milk was run through a separator in 65 minutes. The speed of the separator was said to be 6,000 revolutions per minute. Traces only of butter fat were found in four samples of the skim-milk taken during the process of separation. It required 9.8 c.c. of one-tenth normal alkali to make 50 c.c. of the milk neutral. After ripening for 24 hours the cream was churned. Details are given in the table above.

The butter obtained from the 52 lb. of Brown Swiss milk was about 3 oz. more than the butter fat in the same milk, as indicated by the tests of the new milk. The butter obtained from the 2,035.25 lb. of milk used in the working dairy was 20 lb. more than the butter fat shown by tests of the milk. This is an increase of the churn over the test of 11.5 and 23.6 per cent respectively.

From analyses of the butters, with the records of weights of butter and buttermilk, the account kept with the Brown Swiss milk shows a loss of 0.19 lb. butter fat, or 9.7 per cent of the total weight of butter fat in the milk started with. Although this is not the finest working that can be done, so small a quantity could easily be lost by adhering to the dairy utensils of processes through which the milk passes to make butter. The account kept with the 2,035.25 lb. of milk in the working dairy shows an increase of 1.84 lb. of butter fat over the total quantity in the fresh milk as tested. This figurative creation of butter fat in excess of what there was in the milk is probably due to the water that the 13 wooden boxes absorbed after they were weighed. The helper who packed the butter into the boxes from the churn had weighed the dry boxes, then dipped each one into cold water, filled it with butter, and from the total weight subtracted the weight of the dry box so that the water absorbed by the boxes appears as weight of butter. The salt added to the butter from the Brown Swiss milk was not weighed, but estimated by the helper and the analysis of the butter shows an excessive quantity.

A comparison of the test and the churn has been made at the dairy of this Station, together with an analysis of the butter, and the accounts balanced well. This work, except the last two churnings, was done by one person, and the dairy utensils used were carefully cleaned to prevent any loss of butter fat in the process. The milk used was from one Jersey cow about one month after calving. In four trials the milk was set in Cooley cans with bottom faucet. Another trial [the third in the tables] was made by setting the milk in shallow pans, which were the common kind used for this purpose, but with a hole at one side near the bottom. This hole was closed with a cork until time to skim the milk, when, by pulling the cork, the skim milk was drawn off till the cream fell to the hole and then the cork was replaced.

RECORD OF THE WEIGHTS AND TESTS OF THE WHOLE MILK AND SKIM-MILK.

Date.	Whole milk.			Milk set in Cooley cans in a refrigerator. Temperature 45° to 48° F.	Skim-milk		
	Pounds.	Butter fat. per cent	Butter fat. pounds.		Pounds.	Butter fat. per cent.	Butter fat. pounds.
First trial—							
Oct, 16, a. m.	12.18	3.9	0 475	24 hours	9.5	0.2	0.019
Oct. 16, p. m.	10.18	5.8	0 59	12 "	7.93	1.2	0.095
Oct. 17, a. m.	11.64	4.1	0.479	48 "	9.43	0.1	0.009
Oct. 19, a. m.	11.43	3.6	0.411	24 "	9.25	0.2	0.018
Total......			1.955				0 141
Second trial—							
Oct 19, p. m.	10.5	5.8	0.609	36 hours	8.18	0.4	0.0327
Oct. 20, a. m.	12	5.3	0.636	24 "	9.12	0.4	0.0364
Oct. 20, p. m.	10.21	5.2	0.531	12 "	9.12	0.4	0.0365
Oct. 21, a. m.	12.56	4.7	0.589	48 "	10	0.2	0.02
Total......			2.365				0.1256
Third trial, milk set in shallow pans, temperature 45° to 48° F.—							
Nov, 5, a. m..	9.75	3.7	0.36075	24 hours	8.437	0.05	0.004218
Nov. 5, p. m..	8.5	4.6	0.391	12 "	7.18	0.4	0.02872
Nov. 6, a. m..	9.84	4.1	0.40359	24 "	8.312	0.1	0.008312
Nov. 6, p. m..	8.56	5.2	0.44525	12 "	6 75	0.2	0.0135
Total......			1.60059				0.05475
Fourth trial—							
Oct. 31, p. m.	8.18	4	0 3275	36 hours	6.375	0.2	0.01275
Nov. 1, a. m..	9.69	3.9	0,3778	24 "	7.75	0.2	0.0155
Nov. 1, p. m..	7.51	5	0.375	12 "	5.593	0.7	0.03916
Nov. 2, a. m..	10.37	5.2	0.5395	24 "	7.75	0.2	0.0155
Total......			1.6198				0 08291
Fifth trial—							
Nov. 8, p. m.	8.93	5	0.4468	36 hours	6.437	0.2	0.c1287
Nov. 3, a. m.	9.88	4.6	0 4542	24 "	7.312	0.1	0.00731
Nov. 4, a. m.	11.25	4.4	0.492	48 "	9	0.1	0.009
Nov. 4, p. m.	7.94	5.7	0.4524	12 "	5.562	1	0.0556
Total......			1.8454				0.08478

The results from the five churnings (next page) illustrate a gradual change from a loss to a profit by attention to the proper temperature and acidity of the cream churned. In the first trial the temperature of the cream was too high and the cream was not sour enough. This caused a loss of 5.3 per cent of butter fat in the buttermilk; and the butter obtained was 10 per cent less than the total quantity of butter fat in the milk used.

A test of the buttermilk is a good guide for judging of the thoroughness of the churning, and in the above record it can be seen that the per cent of butter fat in the buttermilk gradually decreases from the first to the fifth trial, in which the cream was churned in about proper condition as to temperature and acidity, giving a buttermilk which contained only 0.1 per cent butter fat and a weight of but-

RESULTS OBTAINED FROM THE CHURNINGS.

	First trial.	Second trial.	Third trial.	Fourth trial.	Fifth trial.
Temperature of cream churned, F....	68°	80°	66°	62°	58°
Temperature of buttermilk, F........	64	74	62	60	58
Time of churning, minutes...........	15	3	10	7	20
Acidity of buttermilk [50 c.c.=1-10 normal alkali]....................	13 c.c.	35.5c.c.	28.5c.c.	36.5c.c.	41.6c.c.
Weight of buttermilk, lb.............	8	8.56	3.875	6	6.78
Per cent of fat in buttermilk..........	5.3	4.9	1.25	0.35	0.1
Weight of unsalted butter from churn..	1.75	2.34	1.8125	1.84	2.156
Weight of butter fat by test of milk...	1.955	2.365	1.6006	1.619	1.848
Difference—loss or gain in the process	—0.205	—0.025	+0.2119	+0.221	+0.308
Per cent which loss or gain was of total butter fat in milk used......... ...	**—10.4**	**—1.06**	**+13.24**	**+13.64**	**+16.65**
Analysis of butter—					
Water, per cent..................	19.56	21.33	15.66	14.95	15
Butter fat, per cent...............	78.94	77.	82.54	83.27	83.2
Curd, per cent....................	1.5	1.67	1.8	1.78	1.8
Total	100.00	100.00	100.00	100.00	100.00
Pounds of butter fat in in the butter..	1.381	1.8018	1.496	1.535	1.7939
Pounds of butter fat in the buttermilk.	0.424	0.4194	0.0484	0.021	0.0067
Pounds of butter fat in skim-milk.....	0.141	0.1256	0.0547	0.083	0.0847
Total...........................	1.946	2.3470	1.5991	1.639	1.8853
Pounds of butter fat in the milk used, as shown by test..................	1.955	2.365	1.6006	1.619	1.848
Difference—loss or gain in the process.	—0.009	—0.018	—0.0015	+0.02	+0.037
Per cent. which loss or gain was of total butter fat in milk used.............	**—0.46**	**—0.7**	**—0.1**	**+1.23**	**+2.**

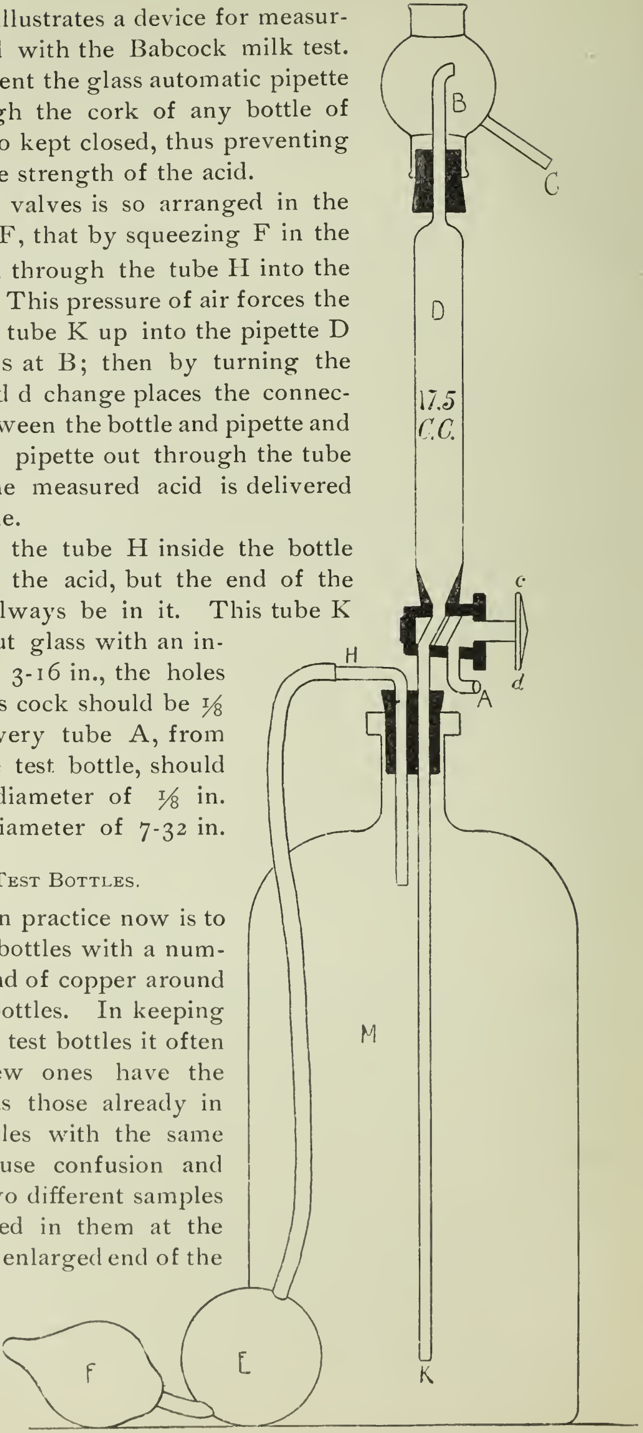
ter 16 per cent greater than the butter fat in the original milk. The butter was weighed and a portion taken for analysis before it had been worked. This accounts for the large per cent of curd found by the analysis. The cream used in these five churnings was separated from the milk in different ways. All the milk was set at a temperature of 45° to 48° F., either in Cooley cans with bottom faucets, or in shallow pans. The cream was not skimmed from the milk in the shallow pans, but the skim-milk was drawn off at the bottom of the can, as before described.

AUTOMATIC PIPETTE.

This figure illustrates a device for measuring the acid used with the Babcock milk test. By this arrangement the glass automatic pipette can be put through the cork of any bottle of acid, which is also kept closed, thus preventing any change in the strength of the acid.

A system of valves is so arranged in the rubber bulbs E, F, that by squeezing F in the hand air is forced through the tube H into the bottle of acid M. This pressure of air forces the acid through the tube K up into the pipette D until it overflows at B; then by turning the cock so that c and d change places the connection is closed between the bottle and pipette and opened from the pipette out through the tube A from which the measured acid is delivered into the test bottle.

The end of the tube H inside the bottle should not touch the acid, but the end of the tube K should always be in it. This tube K should be of stout glass with an inside diameter of 3-16 in., the holes through the glass cock should be ⅛ in., and the delivery tube A, from the pipette to the test bottle, should have an inside diameter of ⅛ in. and an outside diameter of 7-32 in.



MARKING TEST BOTTLES.

The common practice now is to mark milk test bottles with a numbered ring or band of copper around the neck of the bottles. In keeping up the supply of test bottles it often happens that new ones have the same numbers as those already in use. Two bottles with the same number may cause confusion and guess work, if two different samples of milk are tested in them at the same time. The enlarged end of the the neck of the test bottle often breaks off, and though the break may not be sufficient to prevent using the bottle, the copper band easily slips off and is lost.

A simple and efficient way of marking test bottles is to grind a label on them with a file. Wet with water a flat side of a three-cornered file and use the wet side of the file. File a space about one-fourth inch square at any convenient place on the test bottle, thus making the smooth surface of the glass rough and on this ground label mark numbers with a lead pencil. A good place to file the label is either above or below the graduations on the neck of the test bottle.

Experiment No. 122. Composite Milk Samples tested for Butter Fat.

A report was made in bulletin No. 16 of this Station of trials at the creamery of H. B. Gurler, DeKalb, and at the Station dairy of a method of using composite samples in testing milk. The method of collecting the samples was first described by Professor Patrick in bulletin No. 9 of the Iowa Station. The formula tested in the trials made at DeKalb had been sent by Professor Patrick to Mr. Gurler at his request. As pointed out by Professor Patrick an objection to his method is that the preservative used is a violent poison. To avoid this objection a comparison was made of his method with one suggested by the writer, in which the milk was not poisoned but collected for a week and allowed to sour. By adding to a pint of the sour milk about one-half a teaspoonful of "powdered lye" and mixing carefully, it was demonstrated that composite samples of milk could be accurately tested for butter fat without the use of corrosive sublimate.

This use of "powdered lye" has proved very practical and satisfactory in a number of creameries during the past six months and is now in constant use by them. It has been found to be advantageous to add the lye to the milk the night before the test is to be made, and in not too great quantity. Adding too much lye makes the milk stringy or clotted. When small lumps of curd are slow in breaking up, a more complete mixing is obtained by setting the jar of milk into warm water at about 140°F.

Mr. H. B. Gurler, DeKalb, Ill., contributes the following statements and figures obtained by his use of the methods:

"I am satisfied that the use of lye in the weekly composite samples puts them in condition to give a correct sample for testing. As the weather gets cooler we use less of the lye, and there is more need of warming the jars containing the composite samples, as the cream is liable to adhere to the sides of the jars if lye is not used and they are not warmed. On the whole we are very much pleased with the use of the lye.

"The following table gives the tests or per cents of butter fat in the weekly composite samples of milk brought to the creamery by twenty patrons during October.

BUTTER FAT SHOWN BY WEEKLY COMPOSITE TESTS, PER CENTS.

No. of	Week Ending October					No. of	Week Ending October				
Patron	2d	9th	17th	24th	30th	Patron	2d	9th	17th	24th	30th
1	4.3	4	4	4 4	4.2	11	3.9	3,7	3 5	3.4	3.2
2	3.6	3.3	3,6	3.7	3.5	12	3.6	3.7	3.6	3.4	3.4
3	3.6	3.5	3.6	3.7	3.7	13	3 9	3.7	3.8	4	3.8
4	3.6	3.5	4	4	4.2	14	4	3.9	4	4	4.1
5	3.8	3.6	3.6	3.6	3.6	15	3.7	3.8	4.2	4	4.1
6	3.9	3.6	4	4.1	3.9	16	4	3.6	3.8	4	4.1
7	3.8	3.8	3.8	3.4	3.6	17	3.6	3.6	3.4	3.6	3 7
8	4 4	4.8	4.4	4	3.9	18	3.6	4	4	3.8	3.6
9	3.5	3.6	3.4	3.8	out	19	4.2	4.6	4.4	4	4.2
10	4	4.3	3.8	4	4.4	20	3.6	3.6	3.6	4	3.8

"Some of the variations I can account for. No. 11, for instance, had a steady increase in milk from fresh heifers. Some had a decrease from their cows drying off. In the summer months when the conditions of the different dairies were more uniform, the tests ran with a surprising uniformity."

Experiment No. 131. Cream Separation, Test of Methods.

A number of trials were made to observe the completeness of the cream separation after the milk had been set in Cooley cans, temperature 45° to 48°F., 12, 24, 36, and 48 hours. Tests for butter fat were also made of the skim-milk in the bottom and the middle of the can, and of that last drawn off.

The results show that cream is often lost if the skim-milk is drawn off nearer than one inch from the bottom of the cream. The variation in the tests given in the table on p. 29 under the column headed "last skim-milk" shows the necessity of caution in skimming close to the cream. Drawing off the skim-milk to within one inch of the bottom of cream can be done without loss of cream, if the faucet is set so that the skim-milk does not stop running until it has reached the point where you wish it to stop; repeated opening and closing of the faucet has a tendency to mix the cream so that it flows out with the skim-milk.

The summary of this table shows that when the milk of this cow was set in cans to the depth of ten inches the most butter fat was obtained in the cream when the milk had been set 48 hours. This was not much better than setting the milk 24 hours, but considerably better than setting 12 hours. An average of 2.4 per cent of the total butter fat in the new milk was lost in the skim-milk when skimmed after 48 hours standing; 4.05 per cent after 36 hours; 3.7, after 24 hours; and 12.87, after 12 hours.

One trial of separating the cream by diluting the milk with an equal volume of water, showed that 17.2 per cent of the total butter fat was lost in the skim-milk when skimmed after 2 h. standing. The results obtained from setting the milk in shallow pans showed the most complete separation of cream in this trial. Only 1.62 per cent of the total butter fat of the milk was lost in the skim-milk after standing 24 h., and 5.18 per cent after standing 12 h.

More uniformly complete separations of cream than any of the above can be obtained by using a "Baby" hand separator, which we have repeatedly tested, obtaining skim-milk with less than 0.1 per cent butter fat.

RECORD OF THE WEIGHTS AND TESTS OF THE WHOLE MILK AND SKIM-MILK.

Date.	New milk set. lb.	Per cent butter fat in Milk used.	Skim-milk drawn Bottom.	Middle.	Last.	Total.	Per cent of tota butter fat of new milk left in skim-milk.	
Milk skimmed after standing 12 hours.								
Oct. 16	10.18	5.8	0.6	0.8	2	1.2	15.76	Average. 12.87
Nov. 1	7.5	5	0.4	0.6	0.7	0.7	10.55	
Nov. 4	7.93	5.7	0.5	0.8	3.9	1	12.3	
Nov. 5	*8.5	4.6	0.1	0.2	1.9	0.4	*7.34	5.18
Nov. 6	*8.56	5.2	0.2	0.3	0.5	0.2	*3.03	
Milk skimmed after standing 24 hours.								
Oct. 16	12.22	3.9	0	0	0.5	0.2	3.9	3.7
Oct. 19	11.43	3.6	0	0.1	1.9	0.2	4.38	
Oct. 20	12	5.3	0	0.3	0.7	0.4	5.34	
Nov. 1	9.68	3.9	0.2	0.3	0.3	0.2	4.1	
Nov. 2	10.37	5.2	0	0	2.2	0.2	2.87	
Nov. 3	9.87	4.0	0	0	0.4	0.1	1.6	
Nov. 5	*9.75	3.7	0	0	1.4	0.05	*1.17	1.62
Nov. 6	*9.84	4.1	0	0.2	0.4	0.1	*2.06	
Milk skimmed after standing 36 hours.								
Oct. 19	10.5	5.8	0	0.2	6.6	0.4	5.37	4.05
Oct. 31	10.18	4	0	0.1	0.8	0.2	3.9	
Nov. 2	8.93	5	0	0.1	2.1	0.2	2.88	
Milk skimmed after standing 48 hours.								
Oct. 17	11.68	4.1	0	0	0.4	0.1	2	2.4
Oct. 21	12.59	4.7	0	0	1.8	0.2	3.4	
Nov. 4	11.25	4.4	0	0.1	1.6	0.1	1.81	
Milk diluted with an equal weight of water and skimmed after standing 2 hours.								
Nov. 7	9.62	4.9	0.4	0.5	0.5	0.5	17.2	

SUMMARY—PER CENT OF THE TOTAL BUTTER FAT IN THE MILK LEFT IN THE SKIM-MILK

	Milk set in cans, depth of milk 10 in.				Milk set in shallow pans.		Diluted with one-half water.
Time of setting, h.	12	24	36	48	12	24	2
Per cent of total	12.87	3.7	4.05	2.4	5.18	1.62	17.2

*Shallow pan, milk 3 inches deep.

MILK SET IN SHALLOW PANS 3 IN. DEEP AND IN BOTTLES 6 AND 9 IN. DEEP.

No. trial	Manner of setting.	Temp. F. of milk when Set.	After 1 h.	After 2 h.	Per cent of butter fat in Milk used.	Skim-milk after standing 1 h.	2 h.	3 h.	6 h.	9 h.	24h.
1	Shallow pan, depth 3 in......	95°	82°	77°	3.3	....	1.9	1.5	0.8	0.6	0.1
	Bottle, depth 6 in............	95	....	....	3.3	2.9	2.3	2.1	1.4	0.9	....
	Shallow pan, half water, 3 in.	73	71	70	3.3	....	0.4	0.25	0.1	0.05	....
2	Shallow pan, depth 3 in......	97	85	79	2.9	2.5	2	1.6	1	0.6	0.15
	Bottle, depth, 9 in	97	....	....	2.9	2.7	2.3	2	1.5	1.2	0.5
	Pan, half water, 3 in.........	75	72	72	2.9	0.6	0.4	0.3	0.15	0.05	....
3	Shallow pan, depth 3 in......	96	85	82	3.45	2.4	2	1.6	1	0.7	0.4
	Bottle, depth 9 in............	96	86	82	3.45	2.8	2.4	2.2	1.6	1.2	0.9
	Pan, half water, 3 in.........	76	74	74	3.45	0.5	0.4	0.3	0.1	0.05	....

During the hot weather in July a comparison was made of the rate at which cream would rise when the milk was 3, 6, and 9 in. deep. A mixture of milk from several cows was used and it was set in a room where the temperature was about 70°F. In each trial the cream rose faster and more completely in the shallow pans 3 in. deep than when set in bottles 6 or 9 in. deep. See foregoing table for results.

Experiment No. 115. Cream Raising by Dilution.

The observations here recorded include a comparison of the rate at which cream rises in hot weather, when the milk of different cows is diluted with an equal volume of water. The benefits of this practice are supposed to be obtained by dairies which do not have ice or a cool place in which to set milk, and where in hot, muggy weather the milk sours before all the cream rises. Under such circumstances it has been suggested that the cream can be separated at once, by adding cold water to the new milk.

EQUAL PARTS NEW MILK AND WATER.

		Temperature, F.					Per cent. of cream	Per cent of butter fat in				
		Dairy	Milk	Water	Diluted milk			Milk used.	Diluted skim-milk after			
					When set.	After 2 h.			1 h.	2 h.	6 h.	9 h.
Cow No. 1—July	1	74°	88°	54°	68°	.....	7.3	.....	1.1	.....	.....	0.4
	2	77	98	60	76	.....	7.3	5.8	1.2	.....	.....	0.5
	3	73	98	59	76	.....	7.3	5.6	1.3	.....	.....	0.5
	9	72	99	58	73	74°	7.4	5.9	1.7	1.3	0.6	0.5
	10	73	99	58	74	74	7.4	5.4	1.7	1.2	0.8	0.5
	11	75	99	59	76	74	7.4	6.3	1.5	1.3	....	0.4
Cow No. 2—July	1	74	88	54	66	.....	7.5	.....	0.3	....	.....	0.0
	2	77	98	60	75	.....	7.3	.....	0.8	.....	.....	0.2
	3	73	98	59	76	.....	7.3	.....	0.7	.....	.....	0.15
Cow No. 3—July	9	72	99	58	74	75	5.9	3.5	0.6	0.5	0.2	0.2
	10	73	99	58	75	75	5.9	2.9	0.7	0.5	0.3	0.2
	11	75	99	59	76	75	5.9	3.2	0.6	0.5	.....	0.15
Cow No. 4—July	1	74	88	54	66	.....	6	.....	0.3	.....	.....	0.15
	2	77	98	60	75	.....	4.5	2.8	0.7	.....	.....	0.4
	3	73	98	59	76	.....	4.5	2.8	0.6	.....	.....	0.35
	9	72	99	58	75	75	5.9	2.9	0.8	0.4	0 2	0.2
	10	73	99	58	76	75	5.9	2.6	0.9	0.5	0.3	0.1
	11	75	99	59	77	75	5.9	3	.....	.....	.....	....
Cow No. 5—July	1	74	88	54	66	.....	5.9	.....	0.4	.....	....	0.15
	2	77	98	60	74	.....	4.4	3.4	0.8	.....	.....	0.3
	3	73	98	59	76	.....	4.4	3	0.7	.....	.....	0.25
Mixed milk, July Cows 1, 2, 4, 5.	1	74	88	54	68	.....	7.4	.....	0.35	.....	.....	0.2
	2	77	98	60	75	.....	5.9	3.8	0.6	.....	.....	0.25
	3	73	98	59	76	.....	5.9	3.45	0.7	.....	.....	0.35
Mixed milk, July Cows 1, 3, 4.	9	72	98	58	73	75	7.4	3.3	0.6	0.4	0.15	0.1
	10	73	98	58	75	75	7 4	2.9	0.65	0.4	0.3	0.2
	11	75	99	59	76	75	7.4	3.45	0.6	0.4	0.3	0.2

The following trials were made to demonstrate how thoroughly the cream can be separated in this way, and what results would be obtained with the milk of different cows. About one-half a pint of new milk was mixed with the same quantity of water. The mixture was put into wide mouthed glass bottles with a faucet at the bottom by which portions of skim-milk were drawn off for testing. The mixture filled the bottles to a depth of 4 inches. The temperature of the milk was about 98° F. when mixed with water of about 58° F. The temperature of the mixture was about 75° F., and it was kept in a room where the temperature ranged from 66° to 76°F. A test was made of the skim-milk after the mixture had stood 1, 2, 6, and 9 hours.

The details are given in the foregoing table:

The milk used, 250 c.c., was carefully measured each time. A calculation has been made to show the per cent of the total butter fat of the milk which was left in the skim-milk.

PERCENTAGE OF TOTAL BUTTER FAT LEFT IN THE SKIM-MILK.

Milk set.	1 hour.	2 hours.	6 hours.	9 hours.
Cow No. 1, av. of six trials....	46	35.5	22.4	14.9
3, av. of three trials..	35.5	28.7	14.7	10.4
4, av. of six trials....	50	33	16.8	17.3
5, av. of three trials .	43	....	....	15.8
Mixture, 1, av. of three trials..	31.5	....	....	15
2. av. of three trials..	34.7	23.3	13.9	10.4
Average..................	40.1	30.1	17	14

These tables show that there was quite a variation in the per cent. of butter fat found in the diluted skim-milk from the milk of the same cow on different days. These variations were not so great, however, as that of cow No. 1 from all the others. The milk from cow No. 1 was considerably richer than that from the others and gave a richer skim-milk, but it contained about the same proportion of the total butter fat as the milk from the other cows.

The average of all the results obtained shows that in this trial when new milk was diluted with an equal volume of cold water and kept in a room at about 75°F., there was left in the skim-milk about 40 per cent. of the total butter fat after standing one hour; 30 per cent after two hours; 17 per cent after six hours; and 14 per cent after nine hours.

An experiment was next made to ascertain whether the quick raising of cream by dilution was caused by the sudden change in temperature or by the dilution of the liquid through which the fat globules rise.

The bottles used before were filled to the same depth with new milk. They were then put into a refrigerator until the milk had cooled to about 75°F., taken out and kept in a room at 70° to 75°F.

The details of the record are given in the table.

MILK SET IN REFRIGERATOR TWO HOURS.

	Temperature of refrigerator, F.	Temperature of milk, F.		Per cent of cream	Per cent fat in				
					Milk used.	Skim-milk after			
		Set.	Af. 2 h.			1 h.	2 h.	6 h.	9 h.
Cow No. 1.—July 16	51°	95°	72°	20	6	2.3	1.8	0.9	0.7
" 17	58	96	76	20	7	2.2	1.2	0.8	0.3
Cow No. 3.— " 16	51	99	71	6	2.8	2.2	1.8	1	0.4
" 17	58	100	76	6	3.3	2.1	1.1	0.8	0.4
Cow No. 4.— " 16	51	100	71	6	2.6	2.5	2.5	1.9	1.6
" 17	58	100	76	6	3.1	2.8	1.9	1.7	0.8
Mixed Milk, " 16	51	96	72	8	3	2.4	2.2	1.4	0.9
4 in. deep. " 17	58	97	76	8	3.4	2.5	1.6	1.1	0.5
Mixed Milk, " 16	51	94	75	..	3	2.7	2.3	1.6	1
9 in. deep. " 17	58	95	79	..	3.4	2.4	1.6	1.2	0.6
Mixed Milk, " 16	51	94	73	..	3	2.2	1.7	0.8	0.5
pan 3 in. deep. " 17	58	95	76	..	3.4	2.1	0.8	0.5	0.2

An average of the duplicate trials shows a great difference in the cream rising on milk of the different cows. There is not near the uniformity that was observed when the milk was diluted with water.

The same calculation used before shows the per cent of the total butter fat of the whole milk left in the skim-milk to be as follows:

PER CENT OF THE TOTAL BUTTER FAT LEFT IN THE SKIM-MILK.

Milk set.	1 hour.	2 hours.	6 hours.	9 hours.
Cow No. 1.—July 16.........	30.6	24	12	9.3
" 17.........	25.1	14	9	3.4
Average	26.8	19	10.5	6.3
Cow No. 3.—July 16.........	73.5	60.3	33.5	13
" 17.........	60	31	22.6	11.3
Average	67.7	45.5	28	12.1
Cow No. 4.—July 16.........	90	90	69	57
" 17.........	85	57	50	24
Average	88.5	73.5	59.5	40.5
Mixed Milk.—July 16........	73	70	43	27
" 17......	67	43	30	14
Average	70	56.5	36.5	15.5

The results from this work on cream raising by dilution, show [1] that with rich milk and with that from a new milch cow, the cream rose as completely when the new milk was quickly cooled to 70° F. without the addition of water as it did when diluted with an equal quantity of water. [2] The rising of the cream was more complete in a given time, and was hastened by diluting the milk from cows that were not fresh or that gave a considerable quantity of average milk.

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Agricultural Experiment Station.

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EXPERIMENTS WITH OATS, 1891.

This article gives results of experiments with oats conducted during 1891, in regard to rate of seeding, depth of sowing, and comparison of varieties. Comparisons are also made with results of similar experiments in previous years.

The trials were all made on the fertile, dark-colored prairie soil of the Station grounds. The season was unusually favorable for oats. In central Illinois, as well as over much of the United States, larger yields were reported than for many years past. The weight per bushel was also very large. The rainfall during the season of growth was unusually light—6.51 inches for April, May, and June, while the average for these months for ten years has been 12.68 inches. The rainfall during the autumn and winter preceding had also been very light—11.17 inches for the six months from October to March. The average temperature for the three months of growth was nearly the same as in 1890

Rainfall and Temperature.

	Average of 10 years.		1889.		1890.		1891.	
	Rain, in.	Temperature.	Rain, in.	Temperature.	Rain, in.	Temperature.	Rain, in.	Temperature.
April ...	3.19	52.4°	0.61	52°	4.11	52.3°	3.54	52.8°
May....	4.45	64.6	5.52	59.2	3.56	58.3	0.89	58.4
June ...	5.04	71	6.81	65.5	3.8	74.6	2.08	72
	12.68		12.94		11.47		6.51	

and as the average for ten years, except in May, in which it was 6.2 degrees cooler.

In all cases, except in testing the effect of depth of covering, the oats were sown broadcast by hand.

The largest yield of grain was from sowing 3.5 bu. per acre, with little variation between the plats sown at rate of 2, 2.5, 3, 3.5 and 4 bu. per acre. The average yield for four years was slightly larger when 3.5 bu. were sown, with comparatively little difference whether 2, 2.5, 3, 3.5 or 4 bu. were sown. For the four years' sowings, one or one and one-half bu. gave smaller average yields than any of the heavier seedings. The weight of the grain per bushel was less in the case of the light seeding. The yield of straw increased with the increase in rate of seeding. For the two preceding years the lightest seeding gave the largest yield of straw. For the four years there was comparatively little difference in the yield of straw.

The results of the trials of different depths of planting were affected by other causes, yet seemed to give best returns from covering two inches deep, but without great variation from covering one to four inches deep. In trials for four years the best results have not come from covering the same depth in any two years.

In tests of 44 varieties on 55 plats the average yield per acre was 66.6 bu. of grain, weighing 33.5 lb. per bushel and 2,840 lb. of straw. Four varieties gave more than 80 bu., and but one less than 50 bu. per acre. Nineteen varieties on 21 plats gave an average yield of 74.7 bu., with averaging weight of 34.12 lb. per bushel.

In the seed sown there was an average of 71.7 per cent of kernel in the berry, and of 70.3 per cent in the crop. The Virginia winter, with the smallest yield and the lightest weight per bushel, had the largest per cent of kernel in the crop. The smallest per cent of kernel in the crop was 62.1 in a plat of welcome badly down; the other plats of welcome had a large percentage. Omitting these exceptional plats the greatest difference in per cent of kernel in seed was 16; in the crop, 11.8.

The early maturing varieties stood first in average yield of both grain and straw, weight per bushel, and size of kernels, but lowest in per cent of kernel. In 1890 these varieties gave the most grain but the least yield of straw and the lowest per cent of kernel.

The varieties with closed panicles gave a somewhat larger yield of both grain and straw and a larger per cent of kernel than those with open panicles. In 1890, there was little difference in yield.

The white varieties gave the largest average yield of grain and the smallest per cent of kernel; the black stood second in both respects; the few dun-colored stood lowest in yield and highest in per cent of kernel. In 1889, the order was the same throughout. In 1890, the dun-colored varieties stood first and the white last in yield.

No one variety has been shown to be greatly superior to all others. A different variety stood first in yield in each of the three years.

Not counting an exceptionally late variety, there was a difference of 24 days in date of cutting. Five varieties were cut July 6th and two July 30th. Of the 55 plats 28 were cut between July 16th and 20th.

The trials for three years do not show that the yield is determined either by the length, plumpness, or weight of the berry, or by the weight per bushel of the grain. The varieties with long, slender, light berries, and light weight per bushel, have had the largest per cent of kernel, and hence, the highest food value.

Experiment No. 12. Oats, Quantity of Seed per Acre.

The land used for this experiment had been in corn for three years, and was plowed and harrowed the day before the seeding.

April 16th 7 contiguous plats, each 1 x 16 rods, were sown broadcast with welcome oats, at the rate of from one to four bu. per acre, and covered by harrowing twice with a slant-toothed harrow.

When harvested, plat 1, which was sown at the rate of one bushel per acre, was slightly green. Each succeeding plat became more ripe to that of the thickest seeding, which was fully ripe and about 5 per cent lodged.

The following table gives the yield per acre of both grain and straw for each of the four years the experiment has been in progress; also the averages of the four years. For particulars of former seasons see bulletins No. 3, 7, and 12.

YIELD OF OATS FROM DIFFERENT AMOUNTS OF SEED, 1888, '89, '90, '91.

Seed per a., bu.	Grain, per acre, bu.					Straw, per acre, lb.					Lb. per bu.		
	1888.	1889.	1890.	1891.	Av.	1888.	1889.	1890.	1891.	Av.	1889.	1890.	1891.
1	52.5	36.3	25.3	36.7	37.7	3820	4600	2820	1275	3129	25.5	26	28.5
1.5	59.4	33.1	21.6	56.9	42.7	4400	3800	1740	1970	2978	25	26.5	31
2	61.4	42.5	17.5	74.8	49.1	4540	4000	1800	2748	3272	28	24	31.5
2.5	63.8	43.8	29.1	72.6	52.3	4860	3000	2460	2638	3240	28	29	32
3	61.9	47.2	27.5	76.6	53.3	5220	4400	1960	2790	3593	29	29	32.5
3.5	62 5	52.1	24.7	79.7	54.7	4400	4100	2000	3060	3390	29.5	28	32
4	60.6	50.6	21.9	76.3	52.3	4260	3200	2020	3110	3173	29.5	29	32

Experiment No. 15. Oats, Depth of Sowing.

April 8th 60 selected berries of welcome oats were sown in each of twelve rows, ten feet long. The first two rows were covered one inch deep, and each succeeding two rows one inch deeper, rows 11 and 12 being covered six inches deep.

June 16th the oats of rows 1 to 6 were looking fairly well; those of rows 7 to 12, much smaller and of a yellow color.

The sparrows so interfered with the grain that the actual yield could not be ascertained and only the number of panicles was counted for each row.

The relative yield is calculated from the number of panicles, supposing the relation to be the same as in 1890.

NUMBER OF PANICLES AND RELATIVE YIELD OF OATS SOWN AT DIFFERENT DEPTHS FOR FOUR YEARS.

Depth of sowing, in.	1888.		1889.		1890.		1891.	
	No. of panicles.	Relative yield.	No. of panicles.	Relative yield.	No. of panicles.	Relative yield.	No. of panicles.	Relative yield.
1	566	90	407	81	362	100	205	69
2	495	80	424	69	312	76	338	100
3	465	100	434	76	307	65	192	49
4	469	95	439	100	269	65	188	55
5	481	80	....	....	181	29	136	26
6	445	55	....	....	75	12	91	18

Experiment No 84. Oats, Test of Varieties.

The same varieties, 44 in number, have been tested on 55 plats in 1891 as in 1890. The seed, which was from the crop of 1890, was some mixed, nothwithstanding the care taken to keep the varieties separate.

The land used in this experiment consists of three tracts. Tracts (a) and (b), separated by a space of 20 feet, and containing plats 1 to 40, had been in corn for three years. Tract (c), which was 30 rods northwest of (b), contained plats 41 to 52, and had been in corn in 1890 and in oats in 1889. The land was all fall-plowed without removing the stalks.

April 8th plats 1 to 28 were disked lengthwise, sown broadcast with oats at the rate of 2½ bu. per acre by weight, disked crosswise, seeded with clover, and harrowed lightly with a slant-toothed harrow. April 13th plats 29 to 52 were sown, the treatment and quantity of seed being the same as of the other plats.

DUPLICATE PLATS.

In order to determine the degree of inaccuracy incident to the experiment, seven varieties were sown on duplicate plats, as shown in the following table. The duplicates were so arranged as to give the maximum variation likely to occur on the tracts used.

Leaving out of consideration plat 38, of welcome, which was nearly all lodged, the average difference in yield of grain between two plats of the same variety was 6.6 bu. per acre; the least difference, 1 bu., and the greatest difference, 19.9 bu.

A yield of 6.6 bu. per acre by one variety above that of another does not therefore necessarily indicate that, for this season, the one is superior to the other. The varieties giving the largest yield, and also those yielding the least, were widely distributed over the tracts used.

The average difference in the weight of a bushel of oats from plats of the same variety was about 6·7 lb.; the greatest difference, 1½ lb. There seems to be no relation between the yield of oats and the weight per bushel, the size of berries, or the per cent. of kernel.

YIELD OF DUPLICATE PLATS IN 1891.

Name of variety.	Yield per acre.		Lb. straw for each lb. grain.	Lb. per bu.	Ht., in.	No. stubs per sq. ft.	Wt. 100 berries, grams.	Per cent. kernel in berries.
	Grain, bu.	Straw, lb.						
Welcome	75	2840	1.18	33.5	41	37	2.56	70.4
"	72.5	3240	1.4	34.25	42	45	2.48	71.3
"	52.3	2705	1.62	35.25	......	30	2.51	62.1
"	73.7	3500	1.48	32.75	41	34	2.63	68.2
Texas red	63.4	2110	1.04	33	37	39	2.62	74.7
" "	56.6	2750	1.52	34.5	.....	......	....	....
" "	58.7	2440	1.3	34	.....	......	....	....
" "	64.4	2580	1.25	33.5	.....	......	....	....
Pringle's progress..	83.4	2850	1.07	28	38	38	2.34	67.9
" " ..	74.7	2450	1.03	27.75	33	32	2.65	64.5
Early Dakota......	56.6	2470	1.36	30.75	38	46	2.03	73.4
" "	70.8	2895	1.28	31.25	39	32	2.15	74.5
New red rust proof.	61.9	2040	1.03	31	35	33	2.7	74.3
" " " "	67.4	2425	1.13	31.75	35	32	2.86	72.5
Canadian black....	52.3	3005	1.79	32	40	35	2.33	73
" "	59.2	2925	1.54	30.75	38	43	2.28	76.3
Black Russian.....	80.8	3495	1.35	31.75	42	43	2.22	71.4
" "	60.9	2010	1.03	30.75	35	29	2.37	71.4

SYNOPSIS OF VARIETIES.

The same scheme is used in the table, on page 38, as in bulletin No. 12, for the crop of 1890, and, with the following exceptions, the classification is the same:

The varieties, Texas rust proof, Texas red, and new red rust proof, have been changed from the early-maturing to the medium, the last coming also in the late. The variety welcome comes in both the early and the medium. Canada white and Swedish have been changed from the open panicled to the closed; prolific side, common mixed, white Russian, improved white Russian, and black Highlander from the closed to the open; prolific side from berry long to short and Swedish from short to long.

The early-maturing varieties are those harvested July 6th to 14th; the medium, July 16th to 20th, and the late, July 24th to 30th, excepting Virginia winter, which was harvested Aug. 7th, and, being a winter variety, may be left out of the account.

YIELD.

The yield of grain was unusually large, being for the 55 plats an average of 66.6 bu. per acre, and the yield of straw was 2,840 lb. per acre. In 1889 and 1890, respectively, the average yield of grain per acre was 41.2 and 35.2 bu. and of straw, 2,394 and 3,063 lb. For details, see tables on pp. 39–41.

QUALITY.

The average per cent of kernel in the berries of the seed was 71.7; of the crop, 70.3, which was a decrease of 1.4 per cent.

SYNOPSIS OF VARIETIES.

						Yield, bu.	
Oats.	Early.	Panicle open..	White	Berry long..	Early Dakota	63.7	71.3
					Pringle's progress	79	
				Berry short.	White Swede	72.3	69.8
					Early Lackawanna	66.2	
					White bonanza	70.3	
					Second premium	72	
					Welcome	74.3	
					White Victoria	66.6	
					Clydesdale	73.1	
					Hopetown	67.7	
					White wonder	58.7	
					Prize cluster	70.5	
					Badger queen	70.6	
					White Belgian	70.9	
					Hargett's white	61.1	
					Centennial	62.3	
		Panicle closed.	White	Berry short.	Canada white	63.9	
	Medium.	Panicle open..	White	Berry long.	White schonen	67.2	70.1
					American banner	73.4	
					American triumph	69.7	
				Berry short.	Welcome	62.4	63.2
					Prolific side	56.7	
					Wide awake	58.3	
					Improved American	75.2	
			Black.	Berry long..	Black Tartarian	58.3	
			Dun..	Berry long..	Texas rust proof	72.2	65
					Texas red	60.8	
					New red rust proof	61.9	
		Panicle closed.	White	Berry long..	Swedish	65	
				Berry short	Japan	75.8	68
					Baltic white	67.2	
					Probstier	65	
					Egyptian	64.1	
			Black	Berry long..	Black Russian	70.8	72.7
					New Dakota gray	85	
					Black prolific	68.7	
					Prince Edward's Island	66.2	
	Late.	Panicle open..	White	Berry long..	Common mixed	67.2	74.6
					White Russian	76.4	
					Imp. white Russian	80.3	
			Black	Berry long..	Canadian black	55.8	60.9
					Black Highlander	65.9	
			Dun..	Berry long..	Virginia winter	15.9	41.7
					New red rust proof	67.4	
		Panicle closed.	White	Berry long..	Golden giant side	68	68.6
					Giant yellow French	69.2	

Omitting the variety Virginian winter, Canadian black has the largest per cent of kernel in both seed and crop; and, omitting plat 38 of welcome, which was badly down, Clydesdale has the lowest per cent of

Comparative Yield of Varieties of Oats—1891.

Plat No.	Name of variety.	Comparative yield.
23	New Dakota gray	85
5	Pringle's progress....	83.4
21	Black Russian	80.8
46	Imp. white Russian...	80.3
45	White Russian.......	76.4
27	Japan	75.8
33	Improved American..	75.2
31	Welcome	75
52	Pringle's progress....	74.7
47	Welcome	73.7
35	American banner.....	73.4
13	Clydesdale....	73.1
22	Welcome	72.5
6	White Swede	72.3
1	Texas rust proof	72.2
10	Second premium	72
18	White Belgian	70.9
50	Early Dakota........	70.8
17	Badger queen........	70.6
16	Prize cluster.........	70.5
9	White bonanza.......	70.3
36	American triumph	69.7
43	Giant yellow French..	69.2
24	Black prolific........	68.7
42	Golden giant side.....	68
14	Hopetown	67.7
51	New red rust proof...	67.4
44	Common mixed......	67.2
34	White schonen.......	67.2
28	Baltic white.........	67.2
12	White Victoria.......	66.6
25	Prince Edward's Is...	66.2
7	Early Lackawana	66.2
41	Black Highlander....	65.9
29	Probsteir	65
31	Swedish	65
30	Egyptian	64.1
8	Canada white........	63.9
20	Centennial...........	62.3
3	New red rust proof...	61.9
19	Hargett's white.......	61.1
49	Black Russian	60.9
....	Texas red (Av. 4 plats)	60.8
48	Canadian black	59.2
15	White wonder........	58.7
37	Black Tartarian......	58.3
32	Wide awake	58.3
26	Prolific side..........	56.7
4	Early Dakota........	56.6
39	Canadian black	52.3
40	Virginia winter	15.9

kernel in the seed, and Pringle's progress the lowest in the crop. The greatest difference in the seed of two varieties is 16 per cent; in the crop, 11.8 per cent.

YIELD OF OATS OF DIFFERENT VARIETIES; WEIGHT PER BUSHEL; DATE OF RIPENING; WEIGHT OF BERRIES; PER CENT OF KERNEL; NUMBER OF STUBS PER SQUARE FOOT,—1891.

No. of plat.	Name of variety.	Yield per acre		Lb. straw for each lb. grain.	Lb. per bu.	Height, inches.	Ripe and cut July.	Wt. of 100 berries in grams.		Per cent of kernel in berries.		No. of stubs on 1 sq. ft.	Condition when cut.
		Grain, bu.	Straw, lb.					In seed.	In crop.	In seed.	In crop.		
1	Texas rust proof	72.2	2250	0.97	32	37	16	2.71	2.6	74.5	75.5	42	All standing
2	Texas red	63.4	2110	1.04	33	37	16	2.37	2.62	75.8	74.7	39	All standing
3	New red rust proof	61.9	2040	1.03	31	35	16	2.78	2.7	73.6	74.3	33	All standing
4	Early Dakota	56.6	2470	1.36	30.75	38	9	2.34	2.03	73.6	73.4	46	All standing
5	Pringle's progress	83.4	2850	1.07	28	38	6	2.11	2.34	70.5	67.9	38	All standing
6	White Swede	72.3	3225	1.39	37.75	45	6	2.5	2.73	66.7	66.2	31	Mostly standing
7	Early Lackawanna	66.2	2980	1.41	35.75	44	6	2.34	2.3	68.1	68.3	34	Mostly standing
8	Canada white	63.9	3275	1.6	37	46	9	2.46	2.56	66.1	70.3	34	25% down
9	White bonanza	70.3	2950	1.31	36.75	44	6	2.53	2.73	64.9	66.2	36	Mostly standing
10	Second premium	72	2815	1.22	37.25	45	6	2.33	2.61	66.9	67.3	37	Mostly standing
11	Welcome	75	2840	1.18	33.5	41	9	2.06	2.56	69.4	70.4	37	All standing
12	White Victoria	66.6	2910	1.37	38	42	9	2.21	2.57	68.9	74	26	All standing
13	Clydesdale	73.1	3000	1.28	40.5	47	9	2.24	2.92	64.8	69.4	33	All standing
14	Hopetown	67.7	2715	1.25	38	46	9	2.13	2.86	66.6	68.2	40	All standing
15	White wonder	58.7	2320	1.23	40.5	45	9	2.42	2.96	65.7	67.8	43	All standing
16	Prize cluster	70.5	3025	1.34	34.75	44	9	2.31	2.62	68	67.9	37	All standing
17	Badger queen	70.6	3080	1.36	38.25	47	9	2.35	2.73	66.6	68.8	35	All standing
18	White Belgian	70.9	3270	1.44	37.25	48	9	2.16	2.75	66.1	66.5	40	Mostly standing
19	Hargett's white	61.1	2685	1.37	35.5	47	9	2.2	2.67	67.3	65	31	All standing
20	Centennial	62.3	3125	1.57	36.75	45	9	2.33	2.56	70.7	69.1	35	10% down
21	Black Russian	80.8	3495	1.35	31.75	42	20	2.06	2.22	75.8	71.4	43	All standing
22	Welcome	72.5	3240	1.4	34.25	42	16	2.06	2.48	69.4	71.3	45	Mostly standing
23	New Dakota gray	85	3760	1.38	32.75	42	20	2.26	2.43	74	69.4	37	All standing

24	Black prolific	68.7	4520	2.05	29.75	43	20	2.24	2.24	73.9	69.5	41	40% down
25	Prince Edward's Island	66.2	3280	1.55	33.25	40	20	2.33	2.38	72	69.8	30	All standing
26	Prolific side	56.7	2665	1.47	35.25	43	16	2.19	2 40	72.3	71.8	36	All standing
27	Japan	75.8	3435	1.42	39.25	44	16	2.51	2.49	71.4	71.9	39	All standing
28	Baltic white	67.2	4150	1.93	39.75	48	16	2.34	2.54	71.5	70.5	34	Mostly standing
29	Probstier	65	2440	1.17	36.25	40	16	2.55	2.53	72.1	68.9	27	All standing
30	Egyptian	64.1	2590	1.26	37.5	42	16	2.46	2.5	70.8	71.3	30	All standing
31	Swedish	65	2320	1.12	32	40	16	2.18	2.57	74.6	71.7	34	All standing
32	Wide awake	58.3	2375	1.27	32.5	40	16	2.44	2.75	74.5	72.4	33	All standing
33	Improved American	75.2	2775	1.15	33	42	16	2.82	2.54	68.7	72.3	38	All standing
34	White schonen	67.2	2770	1.29	34.5	40	16	2.45	2.51	74.8	74.1	32	All standing
35	American banner	73.4	2430	1.03	33.5	41	16	2.72	2.57	72.3	72.7	34	All standing
36	American triumph	69.7	3050	1.37	30	42	16	1.98	2.11	73.5	71.6	38	Mostly standing
37	Black Tartarian	58.3	2915	1.56	29.75	43	20	1.79	2.15	65	65.4	39	50% down
38	Welcome	52.3	2705	1.62	35.25	—	16	2.06	2.51	69.4	62.1	30	75% down
39	Canadian black	52.3	3005	1.79	32	40	30	2.06	2.33	80.8	73	35	All standing
40	Virginia winter	15.9	2410	4.73	22.25	32	Aug. 7	2.29	2.41	78.4	78.8	39	Mostly standing
41	Black Highlander	65.9	2490	1.18	29.75	33	July 24	2.24	2.57	72.1	68.9	32	All standing
42	Golden giant side	68	2505	1.15	28.75	36	24	2.51	2.67	79.1	70.7	28	All standing
43	Giant yellow French	69.2	2445	1.1	29.25	35	24	2.63	2.58	76.3	70	39	All standing
44	Common mixed	67.2	2270	1.06	32	36	24	2.4	2.63	77	66.8	36	All standing
45	White Russian	76.4	3055	1.25	29.75	40	24	2.63	2.66	77.3	67.4	35	All standing
46	Imp. white Russian	80.3	3170	1.23	32	43	24	2.32	2.77	74.9	71.6	34	All standing
47	Welcome	73.7	3500	1.48	32.75	41	14	2.06	2.63	69.4	68.2	34	All standing
48	Canadian Black	59.2	2925	1.54	30.75	38	30	2.06	2.28	80.8	76.3	43	All standing
49	Black Russian	60.9	2010	1.03	30.75	35	20	2.06	2.37	75.8	71.4	29	All standing
50	Early Dakota	70.8	2895	1.28	31.25	39	14	2.34	2.15	73.6	74.5	32	All standing
51	New red rust proof	67.4	2425	1.13	31.75	35	24	2.78	2.86	73.6	72.5	32	All standing
52	Pringle's progress	74.7	2450	1.03	27.75	33	9	2.14	2.65	70.5	64.5	32	All standing
x	Texas red	56.6	2750	1.52	34.5	..	16	....	....	....	....	..	All standing
y	Texas red	58.7	2440	1.3	34	..	16	....	....	....	....	..	All standing
z	Texas red	64.4	2580	1.25	33.5	..	16	....	....	....	....	..	All standing
	Average	66.6	2840	1.38	33.55	41	..	2.30	2.54	71.7	70.3	36	

From the table of varieties classified, below, it will be seen that the early-maturing varieties are superior to either the medium or late in the average yield of both grain and straw, the weight per bushel and size of berries; but are inferior to either of these in per cent of kernel. As to berries short plump, and long slender, there is very little difference in yield, a noticeable difference in weight per bushel in favor of the short plump, and a difference of 2.1 per cent in kernel in favor of the long slender.

As to berries, white, black, or dun-colored, the white gave the largest yield of grain and the smallest per cent of kernel; the dun-colored gave the smallest yield and the largest per cent of kernel.

As to panicles open or closed, the latter is superior in yield of both grain and straw and also in per cent of kernel.

As to weight per bushel, those which weigh less than 32 pounds are superior in both yield and per cent of kernel. Nothwithstanding the common belief to the contrary, those oats which weigh least to the bushel have usually the highest per cent of kernel, and, consequently, the highest food value. Take, for a striking example, the variety Virginia winter. This season it was least in yield of grain, 15.9 bu., and in weight per bushel, 22¼ lb., but highest in per cent of kernel, 78.8.

YIELD, WEIGHT, PER CENT. OF KERNEL IN VARIETIES AS CLASSIFIED, 1891.

Classification.	No. of plats....	Yield per acre.		Lb. straw for each lb. grain.....	Lb. per bu.....	No. stubs on 1 sq. ft	Height, in......	Wt. of 100 berries in grams.		Per cent. of kernel in berries.	
		Grain, bushels.	Straw, pounds.					In seed.	In crop.	In seed.	In crop.
Maturing early.............	20	69	2919	1.33	35.4	36	43	2.28	2.60	68.2	68.7
Maturing medium	25	66.4	2844	1.34	33.6	36	41	2.29	2.46	72.5	71.1
Maturing late	9	67.3	2699	1.27	30.7	35	34	2.40	2.59	76.9	70.8
Berries, short plump	25	67.3	2964	1.38	36.5	35	44.1	2.32	2.62	68.7	69
Berries, long slender	29	67.7	2914	1.28	31.4	36	38.5	2.33	2.31	74.4	71 1
Berries, white..............	38	68.5	2862	1.31	34.5	35	42	2.34	2.57	70.6	69.6
Berries, black..............	9	66.4	3155	1.49	31.2	37	40	2.12	2.33	74.5	70.6
Berries, dun-colored	7	63.5	2371	1.18	32.8	36	36	2.66	2.70	74.4	74.2
Panicles, open..............	41	67	2769	1.30	33.8	36	41	2.31	2.63	71.2	69.9
Panicles, closed	13	69.2	3094	1.39	33.7	34	41	2.35	2.47	73.3	70.6
Wt. per bu., 32 lb. or more..	38	67.2	2874	1.34	35.3	35	43	2.34	2.60	70.5	69.9
Wt. per lb., less than 32 lb...	16	68.2	2784	1.20	30	36	38	2.29	2.41	74.1	70.6
Wt. of seed per 100 berries, 2.25 grams or more	33	67.8	2794	1.29	34.26	35	41	2.48	2.57	71.8	72.6
Wt. of seed per 100 berries, less than 2.25 grams......	21	67.1	2931	1.38	32.98	36	41	2.11	2.48	71.3	69.5
Kernel in seed, 70% or more..	35	67.3	2787	1.30	32.49	35	39	2.36	2.49	74.2	71.2
Kernel in seed, less than 70%.	19	67.9	2959	1.36	36.09	36	43	2.26	2.63	67.3	68.2
Kernel in crop, 70% or more..	30	66.4	2976	1.30	33.2	36	40	2.37	2.49	73.6	72.4
Kernel in crop, less than 70%.	24	68.8	2741	1.36	34.4	35	42	2.28	2.59	69.4	67.5

Thirty varieties have been tested for three years and 14 additional ones for two years.

The table gives the yield of both grain and straw for each year, also the rank according to yield of grain of the 30 varieties for each of three years and of the 14 for each of two years. The average yield of

YIELD OF STRAW AND OF GRAIN OF THIRTY VARIETIES FOR THREE YEARS, AND OF FOURTEEN VARIETIES FOR TWO YEARS.

Name of Variety.	Straw per acre, lb.				Grain per acre, bu.						
	1889.	1890.	1891.	Av.	1889.		1890.		1891.		
					Rank.	Bu...	Rank.	Bu...	Rank.	Bu...	Av.
30 Varieties tested 3 years.											
Pringle's progress	1700	2580	2650	2310	20	40	3	48.1	2	79	55.7
New Dakota gray	2200	3980	3760	3313	17	41.3	7	39.4	1	85	55.2
Early Dakota	3200	2840	2682	2907	2	51.3	2	48.8	23	63.7	54.6
Japan	2700	3660	3435	3265	4	47.5	6	40.3	4	75.8	54.5
Texas rust proof	1600	3320	2250	2390	30	30	1	55.9	8	72.2	52.7
Giant yellow French	2800	3300	2445	2848	1	53.8	17	34.4	15	69.2	52.5
White bonanza	2000	2560	2950	2503	6	46.3	10	37.5	13	70.3	51.4
Black Russian	2400	3820	2752	2991	14	42.5	5	40.6	10	70.8	51.3
Clydesdale	2200	2960	3000	2720	8	44.1	22	33.8	7	73.1	50.3
Improved American	2500	2660	2775	2645	3	50.3	29	25.5	5	75.2	50.3
Prize cluster	2400	3200	3025	2875	11	42.8	11	37.2	12	70.5	50.2
American banner	2300	2740	2430	2490	7	46.3	25	30.6	26	73.4	50.1
Badger queen	2000	1300	3080	2127	18	40.6	9	37 8	11	70.6	49.7
Welcome	2350	3213	3071	2878	12	42.6	8	38	17	68.4	49.7
White Russian	2500	3220	3055	2925	10	43.4	28	26 6	3	76.4	48.8
New red rust proof	2000	2640	2232	2291	23	36.9	4	45	21	64.6	48.8
Common mixed	2500	3740	2270	2837	5	47.2	24	31.9	18	67.2	48.8
Hopetown	3000	3360	2715	3025	15	42.1	12	35.9	18	67.7	48.6
Egyptian	2300	3320	2590	2737	13	42.5	14	35.9	22	64.1	47.5
Black prolific	2200	3800	4520	3507	24	36.9	13	35.9	16	68.7	47.2
Probstier	2500	3260	2440	2750	19	40	15	35.6	20	65	46.9
White wonder	2100	2540	2320	2320	16	42.1	16	35.6	26	58.7	45.5
White Belgian	2300	3120	3270	2897	28	31.9	21	33.8	9	70.9	45.5
American triumph	2700	3020	3050	2923	25	35.6	27	27.8	14	69.7	44.4
Centennial	2400	2640	3125	2722	22	36.9	23	33.4	24	62.3	44.2
Hargett's white	2400	2700	2685	2595	21	37.2	18	34.4	25	61.1	44.2
Wide awake	2200	2720	2375	2432	9	43.8	26	28.6	27	58.3	43.6
Canadian black	2900	4180	2965	3348	26	33.8	19	34.4	29	55.7	41.3
Black Tartarian	2800	3960	2915	3235	29	30.6	20	33.8	28	58.3	40.9
Virginia winter	2800	3000	2410	2737	27	32.2	30	20	30	15.9	22.7
14 Varieties tested 2 years.											
Second premium white	.....	3200	2815	3007	...	.....	2	41	3	72	56.5
Texas red	.....	2760	2470	2615	...	.....	1	49.7	13	60.8	55 2
Improved W. Russian	.....	3780	3170	3475	...	.....	14	26.5	1	80.3	53
White Swede	.....	2200	3225	2712	...	.....	12	31.1	2	72.3	51 7
White Victoria	.....	3010	2910	2960	...	.....	3	36.9	7	66.6	51.7
Baltic white	.....	3670	4150	3960	...	.....	6	35.3	5	67.2	51.2
Black Highlander	.....	4000	2490	3245	...	.....	5	36.3	10	65.9	51.1
Golden giant side	.....	3350	2505	2927	...	.....	8	33.2	4	68	50.6
Canada white	.....	2550	3275	2912	...	.....	4	36.4	12	63.9	50.1
Early Lackawana	.....	3080	2980	3030	...	.....	9	32.8	8	66.2	49.5
White schonen	.....	2580	2770	2675	...	.....	11	31.9	6	67.2	49.5
Prince Edward's Island	.....	2580	3280	2930	...	.....	10	32	9	66.2	49.1
Swedish	.....	3320	2320	2820	...	.....	13	30.9	11	65	48
Prolific side	.....	3790	2665	3227	...	.....	7	35.3	14	56.7	46

both grain and straw is given for the two or three years, as the case may be, and the varieties of each class are arranged in order of yield of grain, beginning with the highest.

To show that no one variety is unquestionably better than all others (such extravagant claims are not unfrequently made by seedsmen), see the following table, giving the yield and comparative rank of seven varieties out of 30 for each of the three years, during which this experiment has been conducted. It will be seen that a variety which holds a high rank one year may fall to a very low one in the years following, or *vice versa.*

For example, in 1889, Texas rust proof stood at the very foot of the 30 varieties, and in 1890 ranked as the first of 44 varieties, while for this season it ranks as 15th.

Variations in Rank as to Yield of seven Varieties in three Years.

Name of variety.	1889.		1890.		1891.	
	Bu. oats.	Rank.	Bu. oats.	Rank.	Bu. oats.	Rank.
New Dakota gray............	41.3	17	39.4	7	85	1
Pringle's progress...........	40	20	48.1	3	79	2
Early Dakota................	51.3	2	48.8	2	63.7	23
Giant yellow French	53.8	1	34.4	17	69.2	15
Welcome....................	42.6	12	38	8	68.4	17
Texas rust proof............	30	30	55.9	1	72.2	8
Improved American.........	50.3	3	25.5	29	75.2	5

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THE CHINCH BUG IN ILLINOIS, 1891-1892.

The almost uniformly high temperature of the spring and summer of 1890 and 1891 in northern and in southern central Illinois, combined with light rainfall, amounting in some counties to little less than continuous drouth, favored unusually the development of the chinch bug in these sections; and, if similar conditions should prevail for another season, serious loss can hardly fail to ensue, especially in the northern part of the state.

South of central Illinois, the region threatened is a belt of counties extending from about the line of the Ohio and Mississippi Railroad northward to the latitude of Springfield, and local injury is possible for some distance north of this. To the north, the infested district is a roughly triangular area in the northeastern corner of the state, of which Stephenson County marks the western angle and Kankakee County the southern. The distribution of injury within these limits is, of course, extremely variable, as is shown by the following examples of field notes and correspondence; first for southern Illinois, and then for the northern part of the State.

WASHINGTON.—*Nashville*, July 8. "Very destructive to corn in places." Dec. 7. Bugs generally diffused in limited numbers. *Ashley*, Dec. 7. Bugs generally diffused. Injury to wheat slight; corn more hurt.

CLINTON.—*Carlyle*, April 8 and 9. Hibernating in rail fences, corn shocks, etc. Second year here. Corn and wheat suffered some in 1890. Dec. 11. A few bugs. No harm done.

MARION.—*Vernon*, July 1. "Leaving wheat for corn. Threaten injury." *Salem*, Dec. 9. A few bugs in corn. *Odin*, Sept. 27. In large quantities in one field of corn. Dec. 10. Locally abundant.

BOND.—*Greenville*, June 27. "Corn alive with them." Dec. 3. Reported present in limited numbers last season. Effects seen mostly in corn; some wheat light weight. *Smithboro*, July 10. "Destroying corn." Dec. 4. Report similar to that at Greenville Chief injury to corn.

MONTGOMERY.—*Litchfield*, May 27. Found bugs in most wheat fields along the road for four miles south of town. Wheat damaged most on corn ground and in the vicinity of places where corn shocks had stood over winter. Eggs abundant; a few young bugs. June 2. Few eggs seen; young bugs very numerous. From ten to fifteen per cent. of wheat in vicinity where corn shocks stood is ruined. July 18. Chinch bugs very abundant in and near woodlands on gray soil. Scarce on black lands north of them. Several rows of corn killed in many fields adjoining small grains. Scattered traces of insect disease, but not sufficient to promise any important aid. Sept. 23. Bugs collected in corn fields. Every field entered contained bugs enough to excite apprehension for next year.

SHELBY.—*Herrick*, Aug. 24. Second brood of chinch bugs will seriously damage corn; many stalks completely covered. *Shelbyville*, Nov. 16. Bugs present in considerable numbers. Injuries mostly confined to corn.

CHRISTIAN.—*Morrisonville*, July 4. "Leaving wheat for corn. Threaten great damage." *Taylorville*, Nov. 17. General diffusion of bugs reported. Some wheat reduced to light weight; corn next wheat fields injured.

MACON.—*Blue Mound*, May 25. Corn and wheat infested by chinch bugs. June 27. Bugs of all ages, mostly young, present. A quart can nearly full of them sent to the office.

In addition to the above list, a general diffusion of chinch bugs is also reported, with little or no injury, from the counties of Brown, Champaign, Coles, Macon, Sangamon, Effingham, Macoupin, St. Clair, Jefferson, Wayne, Clark, Lawrence, Edwards, White, Hamilton, Randolph, Pope, and Johnson.

St. Clair, Washington, Clinton and Montgomery counties reported the bugs as being present in small numbers in 1890 also. A noticeable feature of the injury to wheat in this part of the state is that it suffered greater damage in the immediate vicinity of corn shocks, where the shocks were permitted to remain over winter.

In northern Illinois the prospect is more serious. Trips of investigation made late in 1891 showed the bugs to have been destructive locally in some nine counties for two years, and in a few places for three years past. Spring wheat, rye, and barley have afforded them the most acceptable breeding places. Destruction of these grains in areas varying from a fraction of an acre up to two, three, or more, acres was common all through the infested region; and spring wheat was frequently light in weight because of the attacks of the bugs. Oats were quite generally infested, but did not suffer so severely as the other small grains, only now and then a small area showing noticeable injury. Corn next to spring wheat, rye, or barley, suffered considerable damage, several rows next such fields often being almost wholly worthless. Fields at a distance from the small grains contained bugs in limited numbers scattered all through them, but were not commonly damaged noticeably. The situation in these northern counties is shown more specifically in the following brief abstracts of field notes and correspondence:

McHenry.—*Marengo*, Oct. 15. Second year of appearance. Great damage to rye, oats, and corn; some rye and corn not harvested. *Woodstock*, Oct. 16. Abundant all over the county. Wheat, corn, and barley attacked; corn not much hurt. Damage greater than last year.

Boone.—*Belvidere*, Oct. 15. Bugs reported five miles from town, where rye was being plowed down because of them.

Winnebago.—*Rockford*, Oct. 17. Abundant all through this region. Rye not much harmed; barley severely attacked; wheat and corn attacked variously. One crop of corn reported not worth gathering; another piece was half destroyed; and one field of seven acres of wheat yielded fifteen bushels gross. *Pecatonica*, Oct. 18. The bugs are in corn nearly a mile from the nearest stubble. Twenty acres of corn two miles north of town quite spoiled by bugs coming out of rye.

Stephenson.—*Ridott*, Oct. 19. Bugs passed from rye to corn, doing no very marked damage to either. On bottom land found bugs on corn with no stubble near. *Lena*, Oct. 20. Bugs generally present, but little complaint of injury. One farmer reports bugs in wheat, going thence into corn and damaging it seriously. *Warren*, Oct. 20. Traces of chinch bugs only.

Kane.—*Hampshire*, Oct. 14. Chinch bugs appeared here two years ago; last year in greater numbers than the year before. This year, barley, wheat, and corn damaged. Wm. Warrington had three acres of wheat destroyed, and H. Gilkerson had fifteen acres of wheat injured and three acres of corn destroyed. A neighbor of his had three or four acres of spring wheat and two or three acres of corn destroyed.

DeKalb.—*New Lebanon*, June 2. "Abundant in wheat and barley." *Genoa*, Oct. 15. Chinch bugs reported in wheat, Hungarian, and corn. They are also found in the vicinity of *Sycamore*. *Shabbona*, Oct. 20. Chinch bugs common in corn. Somewhat injurious.

Ogle.—*Davis Junction*, Oct. 14. Traces of bugs all along the road from here to Stillman's Valley. *Stillman's Valley*, Oct. 14. A few rows of corn next rye and spring wheat injured. *Payne's Point*, Oct. 15. Bugs went from rye into corn; both damaged some. Barley injured also, one acre of corn destroyed, and seven acres badly damaged. *Oregon*, Oct. 15. Five acres of corn east of town reported destroyed. *Chana*, Oct. 15. Bugs generally diffused between here and Payne's Point. Two or three acres of corn destroyed by bugs coming from rye. *Forreston*, Oct. 15. Bugs were flying thickly about this time last year. Hibernated abundantly in woods. Rye, barley, spring wheat, and corn hurt about as badly last year as this. North of town ten acres of rye was so badly damaged as to be plowed up. Five acres of corn badly damaged; much rye, barley, and spring wheat cut before it ripened to save it from the bugs. Reports from *Mt. Morris*, *Baileyville*, and *Rochelle* show the bugs to be generally distributed over the county.

Whiteside.—*Sterling*, Oct. 21. Chinch bugs few, no important damage.

From the foregoing it is evident that the cereal crops of a considerable part of Illinois for the coming season are in danger unless weather conditions intervene to destroy the chinch bug or to check its multiplication, and that with unfavorable weather this year, 1893 may well be dreaded throughout a large part of the state as a year of impending agricultural disaster—all the more difficult to bear because the agriculture of Illinois, and especially that of northern Illinois, will be extraordinarily conspicuous during that Exposition year. We have, therefore, unusual reason to take prompt and thorough-going measures to ward off the injury thus threatened.

Practical measures of defence available for the coming season are limited to the present destruction of the bugs in their winter quarters; to a diminution of their food supply by intelligent cropping; to the support of infested crops by the use of fertilizers and a liberal agricultural method in general; to a destruction of the insects in small grain where they appear very abundantly in patches; to an arrest of their movement and a destruction of them as they pass from field to field at harvest; and to measures for the prompt dissemination and rapid increase of their natural contagious diseases.

The attack on the insect in its winter quarters is to be made by fire, carrying the torch in early spring over headlands, thickets, and borders of woods, and into the wintering places of the pest generally, just as far and as thoroughly as practicable. The drier the rubbish and the earth below, the more certainly will the fire reach the hidden insects. There are commonly a few warm days in spring, just previous to the spring flight of the bugs, when they are creeping actively about near the surface of their winter harborage, at which time a fire running over the ground will kill a greater number of them than if applied earlier. This operation will be more general and easy where the fences are of wire, or where an effective stock law makes fences needless.

The crops to be especially avoided in northern Illinois are spring wheat, barley, rye, Hungarian, and millet.

To support an infested crop against the drain of insect injury the quickly acting soluble fertilizers, containing nitrogen and the phosphates, are the most desirable. The sowing of clover on wheat is a beneficial practice quite generally known to farmers.

Where the bugs settle in the fields in spring in patches, it may be a profitable practice to destroy the young there as they hatch and before they spread, even at a sacrifice of the grain if necessary. A thorough wetting of such patches with the kerosene emulsion will be effective for this purpose. It may be necessary in some cases to cover such areas with straw or dry straw-stack waste, to be burned over afterwards.

As they move from field to field their passage may be arrested and the chinch bugs killed by several procedures more or less generally known. A deep furrow plowed round the field (to be kept cleaned out by hand if necessary), in which the accumulating chinch bugs may be killed mechanically or by the kerosene emulsion is, perhaps, on the whole, the cheapest and the most effective method. A variation of this method, used very successfully in Wisconsin, is to lay fresh corn stalks in the furrow, in which the chinch bugs can be killed as they accumulate, as before, with the emulsion. To prepare this fluid, mix two parts of kerosene with one part of strong hot soap-suds, and violently agitate the mixture with a handforce pump until a permanent cream or butter is produced. This may then be diluted with ten or twelve parts of water, and applied either from a sprinkler with a nozzle, or in a spray from a hand force pump. A minute portion of the mixture is sufficient to kill the bugs of all ages, and of the strength here recommended does not injure corn. It may be used successfully against the bugs collecting on the outer rows of corn, if they succeed in passing the barrier above described.

The fertilization of corn, either in the hill or by general application to the soil, has been proved a very considerable defence against chinch-bug injury.

The subject of the use of contagious insect diseases is still in the experimental stage, the relations of this method to various weather conditions being as yet particularly doubtful. Its promise is such, however, as to make it well worth while for any one interested to try the experiment thoroughly and carefully. For this purpose application should be made to the undersigned for material for infection, a large quantity of which we are now growing by artificial methods for distribution in the spring.

It should be thoroughly understood by everyone that isolated and individual measures, while often productive of great good, are of but little value as compared with a general, co-operative attack undertaken by all the farmers of a threatened neighborhood.

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All communications intended for the Station should be addressed, not to any person, but to the

AGRICULTURAL EXPERIMENT STATION, CHAMPAIGN, ILLINOIS.

The bulletins of the Experiment Station will be sent free of all charges to persons engaged in farming who may request that they be sent.

GEORGE E. MORROW,
President Board of Direction.

UNIVERSITY OF ILLINOIS,

Agricultural Experiment Station.

CHAMPAIGN, APRIL, 1892.

BULLETIN NO. 20.

FIELD EXPERIMENTS WITH CORN, 1891.

This bulletin gives the results of the experiments with field corn in 1891, together with a summary of the results obtained in the same experiments in 1888, 1889 and 1890. The following are reported:

No. 1. Test of varieties.
No. 3. Time of planting.
No. 5. Thickness of planting.
No. 6. Planting in hills or drills.
No. 7. Depth of plowing.
No. 9. Depth of cultivation.
No. 10. Effect of root-pruning.
No. 11. Effect of fertilizers.
No. 90. Growth of the corn plant; increase of its dry matter.
No. 134. Effect of removing tassels.

The experiments, except No. 11, were tried on the dark colored, fertile prairie soils common to central Illinois. The surface soil is about 18 inches deep, underlaid with yellow clay. No manures were applied, except in No. 11. In most cases the land had been in corn in 1890, and was plowed in the spring. In all but a few cases the corn was planted by hand, covered with a hoe, four kernels in hills 3 ft. 8 in. apart each way.

The season was one of severe drouth. The rainfall had been deficent in 1890 and in the early months of 1891. For the five months from May to September it was 7.65 in., the average for this portion of the year being from 18 to 20 in. The average mean temperature for these five months was 68°, which is not far from the average during a series of years.

TEMPERATURE AND RAINFALL DURING THE CORN SEASON OF YEARS NAMED.

	Mean temperature, F.					
Year.................	May.	June.	July.	August.	Sept.	Average.
1887.................	67.9°	73.6°	80.4°	75.2°	66.4°	72.7°
1888.................	59.4°	71.3°	77°	72.4°	62.4°	68.5°
1889.................	59.2°	65.5°	72.7°	69.2°	61.3°	65.6°
1890.................	58.3°	74.6°	73°	68.7°	60.5°	67°
1891.................	58.4°	72°	70°	70.2°	69.2°	68°
Average, 1878–87......	64.6°	71°	77.5°	74.6°	66.5°	70.8°
	Rainfall, inches.					Aggregate
1887.................	3.84	1.62	1.65	2.56	3.68	13.35
1888.................	6.84	5.75	5.34	3.14	1.95	23.02
1889.................	5.52	6.81	5.84	0.60	2.74	21.51
1890.................	3.56	3.80	2.83	1.93	1.19	13.31
1891.................	0.89	2.08	1.41	2.86	0.41	7.65
Average, 1878–87......	4.45	5.04	2.75	3.45	3.27	18.96

Thirty-six varieties were tested on 52 plats. About 86 per cent of a full stand of stalks was secured. About 12 per cent of the stalks produced no ears. This is nearly the same result as found in 1888 and 1890; in 1889 there was less than two per cent of barren stalks. While the percentage of stalks does not seem to depend on variety, there were great differences in different plats—from three to twenty-nine per cent.

As had been the case in each of the three preceding years, the varieties maturing about September 20th gave a larger average yield than those maturing either earlier or later. In 1891, 13 early varieties averaged 56, 19 medium averaged 66, and six late maturing varieties averaged 57 bu. of air-dry corn per acre. For the four years the early varieties gave an average yield of 61, the medium of 73, and the late of 68 bu. of air-dry corn.

For four successive years 11 varieties have been tested. The average yield has been at the rate of 70 bu. per acre. Of these varieties champion white pearl has had the highest average, 79 bu.; Leaming (yellow) the next, 76 bu.; Burr's white, which resembles champion white pearl, next, 74 bu. Boone county white gave much the largest yield, 89 bu., in 1891, and as large as any other in 1890. Leaming gave the largest yield of any yellow variety in 1891. Murdock and Edmonds stood highest in yield of the early maturing varieties tested for four years. A plat of Murdock did not ripen until Sept. 20th, while one plat of Leaming matured so as to be classed with the early varieties; but these were exceptional cases.

In some cases marked differences were found in the yield of adjacent plats of the same variety. In the case of one variety there have been extraordinary variations in yield in different years. In each of the four years varieties little known and without more than a neighborhood reputation have given large yields of good corn. The yield does not seem to depend on the color or the smoothness or roughness of the kernels, although, in 1891, the white varieties gave an average of four bushels larger yield than the greater number of yellow varieties.

A medium sized variety of corn planted at the rate of one kernel each nine to twelve inches in rows 3 ft. 8 in. apart gave larger yields of good corn than thicker planting; but the yield of corn and stalks together increases with thickness of planting, at least up to the rate of one kernel each three inches. As the result of four years trials it is believed the larger yield of grain makes the food value of the total crop greater when it is planted at the rate of one kernel at about each six inches in the row.

In 1891 little difference was found in yield from plats planted with a medium maturing variety at weekly intervals from April 25th to May 23d. Later plantings gave much smaller yields; the ears were not well filled and the corn did not mature thoroughly. For three years previous good crops were had from plantings any time in May. For the four years the best results have come from planting from May 11th to 16th.

In two out of three years no material difference in yield has been found whether the corn has been planted in hills or drills, if the land was kept equally free from weeds.

The yields were nearly the same from three plats of spring-plowed land, one plowed two, and one five, and one ten in. deep. In 1890 land plowed eight inches deep gave a little larger yield than that plowed shallower.

In 1891, for the first time in four years, there was a larger yield from a plat deep cultivated than from one shallow cultivated. A cultivator with narrow spring teeth was used this year in the deep cultivation; in former years, a shovel cultivator. For four years the average yields have been at the rate of 71 bu. from deep, 76 from shallow cultivated plats, and 73 from plats not cultivated except to remove weeds by scraping the surface with a hoe.

No appreciable effect on yield of field corn resulted from cutting the tops when in good condition for fodder, or from removing the tassels from alternate rows as they appeared.

Experiments made for three years illustrate the fact that there is relatively little dry matter in corn during the early stages of its growth. When it had reached half its height it had not more than seven, in full tassel less than 50, and when in the soft milk stage less than 75 per cent as much dry matter as when fully mature. Unless there is loss by dropping of leaves the dry matter increases until the corn is mature.

Experiment No. 1. Corn, Testing Varieties.

Tests of varieties of dent corn have been made for five years. Reports have been made in bulletins No. 4, 8 and 13. During the past two years the number of varieties has been considerably reduced by sifting out those that did not give promise of any special merit. In 1888, 136 varieties were tested, in 1891, 36.

The land used in 1891 had been in corn in 1890 and was fall-plowed. The plats, 53 in number, were each one-fortieth of an acre, 2 rods or nine hills square, and with few exceptions were so planted that corn was growing on every side. May 9th to 14th the plats were disked twice, harrowed once, marked 3 feet 8 inches each way; and the corn was dropped by hand four kernels in a hill and covered about one inch deep with a hoe. May 23d to July 1st all the plats were cultivated three times with a shallow-going cultivator and the weeds remaining were removed with a hoe. When the corn was about ten inches high the number of plants on each plat was counted. After September 5th observations as to ripeness were frequently made. The number of barren stalks, total number of stalks, average height to tip of tassels and the average height to butt of ears were ascertained for each variety.

The plats were husked by thirds, the weight and number of ears being ascertained for each third. The middle third of each plat was taken to the storehouse where it remained for about three weeks, at the end of which time it was again weighed, and the number and weight of both nubbins and ears, and the weight of both shelled corn and cobs ascertained for each lot. A pint jar was filled with shelled corn from each plat and sent to the laboratory for the determination of water.

DUPLICATE PLATS.

The differences in yield of duplicate plats show that, while the soil to all appearances was uniform, and the treatment throughout the same, there are differences of condition that are beyond our control and, not unfrequently, beyond our discovery. There were two or more plats of each of ten varieties. The greatest difference in yield between two plats of the same variety is 20.1 bu. per acre, the average difference, 5.8 bu.; and the least difference 0.3 bu.

YIELD PER ACRE OF AIR-DRY CORN UPON DUPLICATE PLATS, IN 1891.

Variety.	a	b	c	d	Average
Leaming	54.7	72.3	74.8	......	67.3
Legal tender	56	57.6	......	......	56.8
Murdock	62.1	61.8	57.6	57.9	59.8
Edmonds	56.4	60.8	......	......	58.6
Golden beauty	72.2	79.4	......	......	75.8
Champion white pearl	73.6	79.5	......	......	76.5
Burr's white	65	70.5	......	......	67.7
Blue river	65.7	74.9	......	......	70.3
Hickory king	54.6	57.9	......	......	56.2
Helms improved	40.5	37.4	......	......	39

While these differences are considerable, yet they are much less than those found between different varieties of even the same class.

For example, the greatest difference between two plats of the 14 planted to early maturing varieties was 39.7 bu. per acre; of the 26 medium maturing, 35.7 bu.; and of the 9 late maturing, 42 bu. The variety giving the largest yield produced 2.6 times as much as the one giving the least. When the variation in yield of different varieties does not exceed that of the same variety on different plats the results are inconclusive. A greater variation we must attribute, in part at least, to the variety. If single plats are used, it is only after varieties have been tested for a series of years that we can conclude which give the best yields; but there are other important things which can be ascertained by comparative tests; such as time of maturity, size, ratio of ears to stalks, ratio of shelled corn to cob. If several plats of each variety are planted, and the average yields ascertained, these afford a better basis for a comparison of the varieties in respect to yield; for in this way the effect of differences in the conditions of the test is much diminished.

Classification of Varieties.

The table on page 54 gives a classification of the varieties tested this year and the yield of air-dry corn by each variety. It is based upon the time of ripening, color and smoothness or roughness of the outer end of the kernels. Varieties maturing before September 10th are classed as early; those maturing September 11th to September 20th as medium; and those maturing after September 21st as late. The varieties that are very near the dividing lines as to time of maturity, and smoothness or roughness are subject to change from year to year from one class to another, hence we see that the classification for 1891 differs slightly from that of 1890. In two cases duplicate plats of the same variety ripened so as to be classed differently.

Results.*

A summary giving the number of plats in each of the three classes, early, medium and late, and the results for each class for each of four years, is given in the table on page 55. In each of the four years there has been an average of from four-fifths to seven-eighths of a full stand, i. e., four stalks in each hill. In two years, 1888 and 1889, there were more stalks when the corn was ripe than when well up in the spring, showing that some stooling must have taken place. And from the very low per cent of barren stalks in 1889, 1.5, we must conclude that most of the stalks produced by stooling must have borne ears. For 1888, 1890 and 1891 the per cent of barren stalks is comparatively uniform, averaging about 12, and in each of these years it increases with the lateness of maturity.

Though varying much from year to year, owing to the nature of the season, in general the height of both stalks and ears increase with lateness of maturity, as do also the length and circumference of ears. Hickory king, a very late maturing variety, is considerably smaller than

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*For details see pp. 56-59.

SYNOPSIS OF VARIETIES, 1891.

					Yield.
Corn	Early	Yellow	Smooth	Haber's early dent	58.2
				Early Butler	52.2
				Murdock	57.9
				Leaming	54.7
			Rough	Queen of the field	61.4
				Hathaway's early dent	35.4
				Steward's improved yellow	58.4
				Yellow dent	62.6
				Queen of the North	34.3
				Edmonds	58.6
				Champaign	61.3
		White	Smooth	Clarke county champion	57.5
				Dunlap's white	74
	Medium	Yellow	Smooth	Fisk	57.4
				Munns	69
				Murdock	60.5
				Clark's Onarga	63.8
				Clark's Iroquis	65.4
				Clarage	53.6
				Leaming	73.5
				Legal tender	56.8
			Rough	Riley's favorite	56.1
				Chester county mammoth	60.1
				California yellow	69.8
		White	Smooth	Peck's white	55.3
				Huston's white	65.3
				Boone county white	89.3
				Burr's white	67.7
				Champion white pearl	76.5
			Rough	McMillan's white	75.8
				Fisk	65.3
		Mixed	Smooth	Blue river	70.3
	Late	Yellow	Smooth	Pride of Kansas	64.1
				Golden beauty	75.8
		White	Smooth	Helms improved	39
				Hickory king	56.2
			Rough	Ivory dent	66.2
		Mixed	Rough	Cranberry	44.4

the average late maturing variety, and as it comes in twice in a short list of late maturing varieties it reduces the average size.

In general the weight of 100 ears has increased, and the number of ears per acre decreased with the lateness of maturing. The pounds of ear corn, as weighed when husked, which must be taken to make a bushel of air-dry shelled corn, invariably increases with the lateness of maturity. This is due largely to the fact that the per cent of water is greater in the late maturing varieties when husked. In two years of the four the pounds of ear corn as shelled required to make a bushel of air-dry shelled corn was less in the late maturing varieties than in the medium.

SUMMARY OF RESULTS WITH THE THREE CLASSES—EARLY, MEDIUM, AND LATE MATURING—FOR EACH OF FOUR YEARS.

	Average of plats, 1888.			Av. of plats, 1889.			Av. of plats, 1890.			Av. of plats, 1891.		
	27 early.	32 medium.	15 late.	3 early.	42 medium.	22 late.	14 early.	29 medium.	8 late.	13 early.	19 medium.	6 late.
Per cent kernels germinating in apparatus	96	97	90	93	97	96	96	94	93	......	......	......
Per cent germinating in field	84	80	74	70	68	65	81	86	81	87	88.4	87
Per cent full stand of stalks	88	87	85	84	80	78	79	83	79	86.1	86.4	84
Per cent of barren stalks	8	11	13	1.7	1.2	0.5	10	12	13	10.4	12.6	14.8
Average height of stalks, feet	9.8	11.5	12.2	6.9	8.9	9.9	8.1	9.6	10.1	6.8	7.7	8.6
Average height of butt of ear, feet	4.5	5.5	6.2	2.8	4.2	4.7	3.5	4.5	5.2	3.4	4.2	4.3
Average height of 3 specimen ears, inches	8.3	9	9.7	7.4	8.1	9.6	8.1	8.3	8.4	7.6	8	7.5
Average circumference of 3 specimen ears, inches	6.3	7	7.2	6.2	6.4	7.2	6.4	6.6	6.2	6.2	6.6	6.2
Average circumference of 3 specimen cobs, inches	3.7	4	4.2	3.4	3.9	4.3	3.7	3.8	3.3	3.7	3.9	3.9
Number of good ears per acre	7597	7482	6263	6520	6695	6055	5374	5292	4651	5464	6334	5112
Number of nubbins per acre	2948	2741	2745	3360	3535	3840	3610	3749	3806	4088	3400	3400
Total number of ears per acre	10545	10223	9008	9880	10230	9895	8984	9041	8457	9552	9734	8513
Weight of 100 good ears, lb	60	74	93	46	72	81	55	61.3	60.1	49.6	58.6	61.3
Weight of 100 nubbins, lb	35	33	51	26	40	43	28	31.9	34.1	28.5	31.6	33
Weight of 100 average ears, lb	53	68	80	39	61	67	44	50	48.7	40.2	48.8	49.8
Lb. ear corn to make bushel when husked	67.2	68.4	71.4	66.1	69.6	72	66.2	67.2	67.1	*66.3	*69.3	*67.7
Lb. ear corn when husked to make bushel air-dry	73.3	78.1	87.8	70.6	81.1	90.2	70.4	73.3	78	72	75.8	86.8
Yield per acre from good ears, bushels	67.5	84	81.2	45.8	68.8	70	44.5	50	47.1	......	......	......
Yield per acre from nubbins, bushels	15.1	18	20.4	13.5	19.7	22.2	14.8	17.7	18.5	......	......	......
Yield per acre, total when husked, bushels	82.6	102	101.6	59.3	88.5	92.2	59.3	67.7	65.6	*58.2	*69.9	*63.9
Yield per acre air-dry corn, bushels	75.6	89.8	83.2	55.6	75.4	73.5	55.6	62	56.6	56.1	66.1	57.4
Loss in drying in crib first year, bushels	7	12.2	18.4	3.7	13.1	18.7	3.7	5.7	9	......	......	......
Per cent of water in corn when husked	18.3	21.8	27.2	16.6	23.8	28.8	16.5	18.4	23.2	*14.3	*15.9	*20.3

* When shelled.

VARIETY OF CORN; SOURCE OF SEED; GERMINATION: STAND; BARREN STALKS; HEIGHT OF STALKS, OF EARS; SIZE OF EARS, OF COBS, 1891

Plat.	Name of Variety.	Seed Received From.		Percentage germinating in field.	Percentage of full stand of stalks.	Percentage of barren stalks.	Height, ft.		Average of 3 specimen ears.		
							Stalks.	Ears.	Length of ear, inches.	Circumference of ear, in.	Circumference of cob, in.
	Yellow dent varieties.										
1	Leaming	University farm	Champaign, Ill	96	92	9	6.8	3.2	7.9	6.3	4.1
2				92	...	...	6.7	3.7	...	...	...
3	Champaign	University farm	Champaign, Ill	93	98	13	7.8	3.5	7.9	6.2	3.7
4				89	...	...	7.3	3.3	...	...	...
5	Legal Tender	Nims Bros.	Emerson, Ia.	92	90	22	7.5	4.5	7.7	8.6	4
6				90	...	...	7.6	3.6	...	...	...
7	Murdock	University farm	Champaign, Ill	92	91	6	7.4	3.2	7.5	6.2	4
8				88	...	...	7.8	3.6	...	...	...
9	Edmonds	H. P. Edmonds	Taylor, Ill.,	91	88	15	7.4	3.5	7.4	6.2	3.6
10				86	...	...	7.4	3.9	...	...	...
11	Queen of the field	Clement Freeman	Princeton, Ill	93	91	4	7.4	3.4	7.6	6.1	3.7
12				92	...	...	6.8	3.4	...	...	...
13	Golden beauty	J. C. Suffern	Suffern, Ill	93	86	10	8.9	4.1	8	6.3	3.6
14				84	...	...	9	4.7	...	...	...
15	Leaming	University farm	Champaign, Ill	96	92	11	8.4	4.3	8.4	6.6	3.8
16				93	...	...	8.3	4.3	...	...	...
23	California yellow	Nims Bros	Emerson, Ia	89	87	8	8.2	4.8	7.2	6.5	3.7
24	Clarage	A. W. Livingston's Sons	Columbus, Ohio	93	81	13	7.8	3.5	7.7	6.2	3.1
25	Clark's Iroquois	H. H. Clark	Onarga, Ill	86	85	17	7.6	4	8.4	6	3.6
26	Clark's Onarga	H. H. Clark	Onarga, Ill.	93	93	13	8.1	4.5	7.6	6	3.4
27	Chester county mammoth	J. C. Vaughan	Chicago, Ill	74	71	14	7.7	3.7	8.5	7.1	4.3
28	Pride of Kansas	Samuel Wilson	Mechanicsville, Pa	81	82	16	8.7	3.9	8.6	6.7	4.3
29	Early Butler	J. J. H. Gregory	Marblehead, Mass	84	96	15	5.7	3.3	7.4	6	3.7
34	Murdock	University farm	Champaign, Ill	92	87	9	7.6	4.2	7.3	6.4	3.9
35	Riley's favorite	Jas. Riley	Thorntown, Ind	81	73	22	7.5	4	7.8	6.7	4
36	Munns	Jas. Riley	Thorntown, Ind	95	95	6	7.9	4.2	8.1	6.2	3.9

37	Fisk's yellow	Eli Fisk	Havana, Ill	87	86	22	8.1	3.6	7.9	6.1	3.6
38	Yellow dent			86	79	8	8.3	3.6	7.9	6.5	3.8
46	Steward's imp. yellow	L. W. Steward	Amanda, Ohio	93	90	15	8	3.9	7.4	6.4	3.6
47	Haber's early dent	K. B. Moorhouse	Urbana, Ill	95	95	8	7	3.4	7.6	5.9	3.7
48	Hathaway's early dent	D. M. Ferry	Detroit, Mich	61	54	8	6.6	3.1	7.5	6.2	3.9
49	Murdock	University farm	Champaign, Ill	91	90	12	7.7	3.6	7.5	6.2	3.7
50	Queen of the north	Salzer Seed Co	La Crosse, Wis	71	77	10	5.6	2.4	7	5.8	3.4
	White dent varieties.										
17	Champion white pearl	J. C. Suffern	Suffern, Ill	83	103+	25	7.6	3.7	8.6	6.5	3.8
18	Champion white pearl	J. C. Suffern	Suffern, Ill	85	......	....	6	3.5	....	....	....
19	Burr's white	University farm	Champaign, Ill	89	91	12	8.2	3.8	8.4	6.7	4
20	Burr's white	University farm	Champaign, Ill	87	......	....	8.1	3.9	....	....	....
30	Hickory King	Samuel King	Mechanicsville, Pa	84	76	13	8.7	4.5	7.1	5.9	2.9
31	Dunlap's white	H. M. Dunlap	Savoy, Ill	92	91	9	8.5	3.7	7.6	6.2	3.6
32	Boone county white	Jas. Riley	Thorntown, Ind	88	80	3	8.7	4.7	7.7	6.7	4.1
33	Ivory dent	R. H. Vanderhoof	Newton, Ill	88	92	16	8.6	4.5	7.2	6 6	4.1
39	Clarke county champion	J. M. McCullough	Cincinnati, Ohio	72	79	10	7.6	3.8	7.6	6.1	3.8
40	Fisk's white	Eli Fisk	Havana, Ill	85	79	14	8.9	4.7	8.7	6.6	4.2
41	Hickory King	Samuel Wilson	Mechanicsville, Pa	79	75	9	8.7	4.2	7.2	5.7	2.9
42	McMillan's white	C. McMillan	Champaign, Ill	85	80	3	8.8	4.1	8.3	6.8	4.1
43	Huston's white	W. H. Coffman	Champaign, Ill	87	88	6	8.7	4.1	....	....	....
44	Helms improved	Fred Helms	Belleville, Ill	85	92	12	9.6	4.8	....	....	....
51	Peck's white	K. B. Moorhouse	Urbana, Ill	90	87	15	7.4	4.4	7.6	6.2	3.8
52	Helms improved	Fred Helms	Belleville, Ill	95	89	29	8.5	4.2	7.2	6.1	3.9
	Mixed dent varieties.										
21	Blue river	Percival Bros	Champaign, Ill	90	89	12	7.9	3.4	8.2	6.8	4.5
22	Blue river	Percival Bros	Champaign, Ill	89	......	....	7.7	3.7	....	....	....
53	Cranberry	J. C. Vaughan	Chicago, Ill	93	85	14	7.2	3.9	6.2	6.4	4.6

VARIETY OF CORN; POUNDS OF EAR CORN WHEN HUSKED, WHEN SHELLED; POUNDS OF EAR CORN PER BU. WHEN SHELLED; BUSHELS SHELLED CORN PER ACRE; TOTAL AIR-DRY CORN; LOSS IN DRYING, 1891.

Plat No.	Name of Variety.	Per ct. water in shelled corn when husked.	Lb. ear corn per acre when husked.	Lb. ear corn per acre when shelled.	Lb. ear corn per bu. when shelled.	Lb. when husked to make bushel air-dry.	Bu. shelled corn per acre.		
							Total as shelled.	Total air-dry.	Loss in drying.
1	Leaming	15.1	4140	3954	68 9	75.7	57.3	54.7	2.6
2		....	4290	....	....	....	....	....	....
3	Champaign	15	4500	4250	66.2	73.4	64.2	61.3	2.9
4		....	4800	.....	....	....	....	....	....
5	Legal tender	19.4	4260	4052	65.5	76.1	61.8	56	5.8
6		15.9	4320	4034	66.1	75	61	57.6	3.4
7	Murdock	17	4800	4560	68.5	77.3	66.5	62.1	4.4
8		18.1	5100	4615	68.7	82.7	67.2	61.8	5.4
9	Edmonds	13.3	3900	3780	65.3	69.1	57.9	56.4	1.5
10		14	4350	4135	65.8	71.5	62.9	60.8	2.1
11	Queen of the field	....	4050	3896	67.1	....	58.1	....	....
12		14.9	4480	4289	66.7	73	64.4	61.4	3
13	Golden Beauty	17.6	6000	5227	67	83.1	78	72.2	5.8
14		18.5	6800	5828	67.2	85.6	86.7	79.4	7.3
15	Leaming	16	5550	5184	67.6	76.8	76.6	72.3	4.3
16		15.3	5720	5291	67.3	76.5	78.6	74.8	3.8
17	Champion white pearl	15	5460	5038	65.4	74.2	77	73.6	3.4
18		15.3	5880	5470	65.5	74	83.5	79.5	4
19	Burr's white	14.1	4830	4527	67.2	74.3	67.4	65	2.4
20		11.1	4920	4699	66.6	69.8	70.6	70.5	.1
21	Blue river	13.8	4860	4616	68.1	74	67.8	65.7	2.1
22		15.5	5480	5257	67	73.2	78.5	74.9	3.6
23	California yellow	15.2	5040	4772	65.3	72.2	73.1	69.8	3.3
24	Clarage	14.6	3900	3721	66.6	72.8	55.8	53.6	2.2
25	Clark's Iroquis	16.2	4860	4544	65.5	74.3	69.4	65.4	4
26	Clark's Onarga	16.1	4680	4364	64.5	73.4	67.7	63.8	3.9
27	Chester county mammoth	17.2	4740	4314	66.8	78.9	64.6	60.1	4.5
28	Pride of Kansas	19.1	5550	4860	68.8	86.8	70.5	64.1	6.4
29	Early Butler	13	3600	3484	65.2	69	53.4	52.2	1.2
30	Hickory king	22.5	4800	4220	63.5	82.9	66.5	57.9	8.6
31	Dunlap's white	14.8	5400	5184	67.1	73	77.2	74	3.2
32	Boone county white	17.2	6930	6422	66.9	77.6	96	89.3	6.7
33	Ivory dent	18.5	5460	4980	68.4	82.5	72.9	66.2	6.7
34	Murdock	15.4	4500	4212	69.6	78.1	60.6	57.6	3
35	Riley's favorite	14.5	4020	3864	66.1	71.7	58.4	56.1	2.3
36	Munns	14.4	4920	4715	67.3	71.3	70.1	69	1.1
37	Fisk's yellow	18.3	4440	4158	66.5	77.4	62.6	57.4	5.2
38	Yellow dent	14.8	4440	4254	65	70.9	65.4	62.6	2.8
39	Clarke county champion	13.2	4080	3965	67.2	71	59	57.5	1.5
40	Fisk's white	19.4	5700	5028	69.6	87.3	72.2	65.3	6 9
41	Hickory king	20.3	4500	3912	64.2	82.4	60.9	54.6	6.3
42	McMillan's white	16	5580	5300	66	73.6	80.3	75.8	4.5
43	Huston's white	18.3	5280	4892	68.8	80.5	71.1	65.3	5.8
44	Helms improved	24.6	4025	3412	71.4	99.4	47.8	40.5	7 3
46	Steward's improved yellow	16	4350	4106	66.3	74.5	61.9	58.4	3.5
47	Haber's early dent	14.4	4170	3967	63.5	71.6	60.5	58.2	2 3
48	Hathaway's early dent	13.0	2520	2428	67.1	71.2	36.2	35.4	.8
49	Murdock	16.3	4380	4135	67.1	75.6	60.4	57.9	2.5
50	Queen of the North	12.7	2340	2308	65.9	68.2	35	34.3	.7
51	Peck's white	15.8	4350	4044	68.4	78.6	59.1	55.3	3.8
52	Helms improved	21.7	3600	3048	71.9	96.2	42.5	37.4	5.1
53	Cranberry	20	3660	3000	66.8	82.4	49.4	44.4	5

NUMBER OF EARS PER ACRE, AND WEIGHT OF 100 EARS, 1891.

Plat.	No. of ears per acre.			Wt. of 100 ears, lb.			Plat.	No. of ears per acre.			Wt. of 100 ears, lb.			Plat.	No. of ears per acre.			Wt. of 100 ears, lb.		
	Good ears.	Nubbins.	Total.	Good ears.	Nubbins.	Average ears.		Good ears.	Nubbins.	Total.	Good ears.	Nubbins.	Average ears.		Good ears.	Nubbins.	Total.	Good ears.	Nubbins.	Average ears.
1	5,466	4,494	9,960	55.11	33.1	45.4	19	5,378	4,782	10,160	57.2	29.3	44.1	36	6,439	4,321	10,760	53.1	29	43.7
2	......	......	9,120	......	......	......	20	4,885	5,395	10,280	55.6	29.3	42	37	5,785	3,215	9,000	56.6	31	47.5
3	5,412	4,948	10,360	47.7	22.3	37.3	21	5,804	4,796	10,600	55.4	32.8	45.2	38	6,283	3,877	10,160	52.4	36.2	39.8
4	......	.....	6,600	......	......	.....	22	7,324	2,836	10,160	61.6	37.5	54.9	39	6,160	2,240	8,400	50.4	32.5	46
5	5,905	3,815	9,720	54.2	26.6	43.3	23	5,950	3,850	9,800	55.3	36.3	47.7	40	6,743	2,697	9,440	69.5	30	58.5
6	7,278	1,242	8,520	58.3	32.3	47.8	24	5,682	2,718	8,400	52.1	32.9	45.8	41	6,059	1,981	8,040	54.3	29.4	48.1
7	6,791	4,049	10,840	56.2	29	46	25	7,063	2,697	9,760	60	32.1	52.3	42	6,308	3,212	9,520	58.1	38.4	51.5
8	7,489	2,031	9,520	59.7	32.8	47.6	26	7,026	3,454	10,480	52.5	23.3	43.1	43	5,849	3,791	9,640	58.7	35.7	49.7
9	5,640	3,840	9,480	48.9	26.5	39.8	27	4,587	3,013	7,600	69.7	36	56.3	44	3,790	3,446	7,236	71.9	36.6	55.1
10	4,496	5,304	9,800	53.2	28.2	39.7	28	4,613	4,267	8,880	70	29	50.3	46	5,380	5,380	10,760	56.5	32.2	44.4
11	5,942	4,778	10,720	41.6	25.3	34.5	29	4,966	4,194	9,160	44.4	25.6	36.1	47	5,367	4,473	9,840	47.1	28.1	38.9
12	6,142	4,138	10,280	50.9	29.6	42.1	30	4,654	4,366	9,020	53.3	34.5	43.9	48	3,060	2,940	6,000	53	26.1	40.3
13	7,382	2,178	9,560	61	37.5	55.7	31	8,837	1,923	10,760	53.6	33.3	50.2	49	4,942	5,058	10,000	51.1	25.5	38.2
14	6,876	2,724	9,600	68.8	40.4	60.8	32	8,342	2,418	10,760	68.1	33.7	60.3	50	3,864	3,736	7,600	38.3	23.3	30.9
15	8,342	2,418	10,760	52.8	28.7	47.4	33	4,961	2,679	7,640	63.5	35.1	53.8	51	5,074	3,806	8,880	58.1	31.6	47.1
16	6,444	3,556	10,000	61.2	33.5	51.3	34	5,067	4,573	9,640	54.8	29	42.6	52	3,853	4,027	7,880	58	25.8	41.6
17	6,215	3,825	10,040	62.9	28.1	49.7	35	6,020	2,580	8,600	61.3	29.1	51.6	53	3,824	4,936	8,760	51.6	29.3	39
18	6,882	3,318	10,200	61.6	32.4	52.1														

Each year the medium maturing varieties have made the largest yield; the average yield of air-dry shelled corn for the four years being 73.1 bu. per acre, which is 12.4 bu. more than the average of the early maturing and 5.4 bu. more than that of the late maturing varieties.

The largest yield in 1891, 89.3 bu. per acre, was made on plat 32 by Boone county white, and exceeds by 9.8 bu. the next greatest yield, which was made on plat 18 by champion white pearl. Boone county white is a medium maturing variety, seed obtained from Jas. Riley, Thorntown, Ind., containing about an average of 17.2 per cent of water and a very low per cent (3) of barren stalks. Two plats only had a greater number of ears per acre, and one only, plat 14 of golden beauty, gives a greater weight per 100 average ears. This same variety also held a high rank in the preceding season, being exceeded by 3.5 bu. per acre only by the largest yield for that season. [See Bulletin No. 13.]

The following table gives the yield for each of eight varieties for five years, and of eleven for four years, arranged in the order of the average yield, beginning with the highest. Of these varieties, champion white pearl, Burr's white, and Helms improved are white; the remainder yellow. Murdock and Edmonds are early maturing, Helms improved is late, and the remaining ones are medium.

A comparison of the white and yellow varieties for 1891 shows an average yield of 64.3 bu. per acre for the white and 60.2 bu. for the yellow.

YIELD OF AIR-DRY CORN OF VARIETIES TESTED FOR THE YEARS NAMED.

Eight varieties tested in	1887.	1888.	1889.	1890.	1891.	Average.
Champion white pearl	20.2	70	94.8	74.9	76.5	67.3
Leaming	29.6	86.6	80.6	69.4	67.3	66.7
Burr's white	30.	85.9	75.7	67.7	67.7	65.4
Steward's improved yellow	32.4	91.2	68.7	54.7	58.4	61.1
Murdock	33.3	80.3	65	61.6	59.8	60
Legal tender	25.8	84.2	68.9	60	56.8	59.1
Edmonds	27.7	83.7	66.3	55.9	58.6	58.4
Riley's favorite	30.8	81.8	66.1	53.3	56.1	57.5

Eleven varieties tested in	1888.	1889.	1890.	1891.	Average.
Champion white pearl	70	94.8	74.9	76.5	79
Leaming	86.6	80.6	69.4	67.3	76
Burr's white	85.9	75.7	67.7	67.7	74.2
Helms improved	84.8	102.6	51.1	39	69.4
Fisk's yellow	76.6	79.5	61.7	57.4	68.8
Clark's Iroquois	68.5	81.9	59	65.4	68.7
Steward's improved yellow	91.2	68.7	54.7	58.4	68.2
Legal tender	84.2	68.7	60	56.8	67.4
Murdock	80.3	65	61.6	59.8	66.7
Riley's favorite	83.7	66.3	55.9	58.6	66.1
Edmonds	81.1	66.1	53.3	56.1	64.3

Experiment No. 3. Corn, Time of Planting.

Experiments to test the effect of time of planting on yield have been conducted for the past four years. Each year the corn was planted on fall-plowed land and the plats were prepared in the same manner just before they were planted.

The ground used in 1891 had been in corn during 1890. The plats, eight in number, were each nine by thirty-six hills, or one-tenth of an acre, and were planted with a medium maturing variety of white dent (Burr's white) four kernels per hill, 3 ft. 8 in. apart each way. The first plat was planted April 25th, and one plat was planted each week thereafter till June 13th. All the plats were cultivated three times with a shallow-going cultivator and the weeds remaining were removed with a hoe. After the corn was well up the number of plants on each plat was ascertained. With the exception of plat 8, which had but little more than half a stand, there was from four-fifths to nine-tenths of a full stand. Beginning with June 8th the tallest stalk in each hill of one row running across the 8 plats was measured each week during the growing season. The average height in inches to the tip of tassel and upstretched leaf for each plat is given in the table for each week.

Average Heights taken weekly in Inches to Tip of Tassel and Leaf.

Plat.		Jun. 8.	Jun. 15.	Jun. 22.	Jun. 30.	July 6.	July 13.	July 20.	July 27.	Aug 3.	Aug 10.	Aug 17.	Aug 24.	Aug 31.	Sep. 7.	Sep. 21.
1	Tassel	....	....	....	....	....	80	93	98	99	99	97	97	97	97	....
	Leaf	26	40	58	81	86	93	98	99	99	100	97	97	96	95	....
2	Tassel	...	....	....	....	....	65	84	96	96	97	96	96	95	95	....
	Leaf	19	31	47	69	75	82	90	95	95	96	95	95	92	92	....
3	Tassel	....	....	....	....	....	54	68	88	101	103	102	103	103	102	102
	Leaf	14	23	36	59	67	75	85	94	100	101	102	100	99	98	98
4	Tassel	....	....	....	....	....	....	53	69	89	97	96	98	98	97	97
	Leaf	8	14	24	41	49	58	69	81	92	95	97	96	94	93	92
5	Tassel	....	....	....	....	....	....	....	54	75	94	94	97	97	94	94
	Leaf	4	9	16	31	39	46	58	73	84	93	94	95	94	93	91
6	Tassel	....	....	....	....	....	....	....	....	....	58	78	95	97	96	97
	Leaf	....	3	9	18	22	28	36	48	58	69	77	91	92	91	90
7	Tassel	....	....	....	....	....	....	....	....	....	65	90	97	97	97	96
	Leaf	....	....	9	18	24	32	40	54	64	77	88	93	93	93	92
8	Tassel	....	....	....	....	....	....	....	....	....	....	72	87	96	96	96
	Leaf	....	....	2	8	12	18	26	38	47	60	76	92	95	94	93

September 5th plats 1 and 2 were ripe, while an occasional husk of plat 3 was turning brown, the remaining plats being green.

October 13th plats 3 to 5 were ripe; 6 and 7, nearly ripe; and 8, quite green.

October 31st to November 2d the corn was husked and weighed, a fifty-pound sample from each plat being taken to the storehouse, where it remained for three weeks, when it was again weighed, shelled, both corn and cobs weighed, and a pint sample of the shelled corn sent to the laboratory for the determination of water.

The per cent of water increased with the lateness of planting. The reason it took so many pounds of ear corn from plat 8 as husked to make a bushel of air-dry shelled corn was not due wholly to the high per cent of water, but was in part because the cobs were not fully filled with kernels. This was due probably to the ravages of some insects upon the silks during the period of pollenization. The same was true to a less extent of plats 6 and 7. There was but little difference in the yield of plats 1 to 5, but 6 to 8 were much lower in yield.

The average yields for the four years are in favor of planting from the 11th to 16th of May, any time in May being safe for a medium maturing variety; but either earlier or later than this there is some risk.

YIELD OF CORN AND PER CENT OF WATER IN CORN FROM PLATS PLANTED AT DATES NAMED, 1891.

Plat.	Dates.	When husked		When shelled.			Bu. per acre air-dry.
		Pounds ear corn per plat.	Pounds to make bu. air-dry.	Pounds ear corn per plat.	Per cent moisture in shelled corn.	Bu. shelled corn per acre.	
1	April 25	355	69.9	349.6	14	52.6	50.8
2	May 2	357	70.8	351.6	14.6	52.6	50 4
3	" 9	344	70.9	337.1	14.8	50.7	48.5
4	" 16	370	74.4	360.7	17	53.3	49 7
5	" 23	421	80	397.8	19.3	57.9	52 5
6	" 30	330	96.8	301.9	24	40	34.1
7	June 8	367	97.9	330.3	23.9	43.9	37.5
8	" 13	248	127.8	217	31.5	25.2	19.4

YIELD OF AIR-DRY CORN FROM PLANTINGS AT DIFFERENT DATES, 1888, 1889, 1890, 1891.

Dates.	Bushels air-dry corn per acre.				
	1888.	1889.	1890.	1891.	Average.
April 22-25	.....	52	.....	51	51
April 27-May 2	80	44	67	50	60
May 4-9	87	51	71	48	64
" 11-16	86	56	75	50	67
" 19-23	87	50	71	52	65
" 26-30	83	55	74	34	61
June 1-8	81	50	61	37	57
" 8-13	50	50	60	19	45

Experiment No. 5. Corn, Thickness of Planting.

On a tract of fall-plowed land 27 rows of corn 3 ft. 8 in. apart, were planted, three rows with single kernels three inches apart; three with single kernels six inches apart; and three with single kernels nine inches apart; also three rows with three kernels every nine inches; three with three kernels every 18 inches, and three with three kernels every 27 inches. This was at the rate of 47,520, 23,760, and 15,840 kernels per acre.

The weight of 100 ears, and of 100 stalks, the number of ears, and the bushels of corn per acre were greatest from the thinnest plantings, and least from the thickest plantings. The total yield and the yield of stalks was greatest from the thickest planting. Corresponding results have been secured in each of the three preceding years.

YIELDS OF CORN FROM PLATS OF THE SAME SIZE, AND WITH THE SAME NUMBER OF ROWS, BUT PLANTED WITH SEED VARYING IN AMOUNT, AND IN MANNER OF DISTRIBUTION, 1891.

Plat.	No. of kernels in hill.	Inches between hills.	No. of kernels planted per plat.	No. of stalks harvested.	Ratio of kernels planted to stalks harvested.	Lb. per acre stalks and corn.	Lb. per acre of stover.	No. of ears per acre.	Average wt. 100 stalks.	Average wt. 100 ears.	Ears harvested to 100 stalks.	Bu. per acre, 70 lb.
1	1	3	1,584	1,141	72	8,437.5	7,500	7,830	22	11.9	23	13.4
2	1	6	792	532	67.2	6,570	4,380	8,850	27.5	24	55	30.4
3	1	9	528	432	81.8	7,350	4,080	9,240	31.5	35.4	71	46.7
4	3	9	1,584	1,146	72.3	7,785	5,940	13,770	17	13.4	40	26.3
5	3	18	792	661	83.5	6,300	4,200	8,730	21	24	44	30
6	3	27	528	376	71.2	5,475	3,060	8,790	25	27.5	78	34.5

A second experiment was made to compare the effect of planting in hills at different distances and with differing numbers of kernels in the hills.

The tract used for this experiment had been in corn in 1890 and was fall-plowed. There were 36 plats, each nine hills square, so planted that corn grew on every side of each plat. May 14th the corn, which was Leaming and Burr's white, two medium maturing varieties, and early Butler, an early maturing variety, was dropped by hand and covered with a hoe. June 1st to 27th the corn was cultivated three times with a shallow-going cultivator and the remaining weeds removed with a hoe.

October 26th to 29th the corn was husked and the number of barren stalks, the total number of stalks, the number of ears and the weight of ears were ascertained for each plat. The distance between hills, the number of kernels per hill, the ratio of stalks grown to kernels planted, the per cent of barren stalks, the number per acre of kernels planted, stalks grown, and ears harvested, the weight of 100 ears, and the yield per acre in bushels (70 lb. per bushel) for each plat of each variety are given in the table.

In general, as the rate of thickness in planting increases the ratio of stalks grown to kernels planted and weight of 100 ears decrease, while the per cent of barren stalks increases. The same is more noticeable in the table giving the average of four plats for each of the six rates of planting. In this table also it will be seen that, excepting the thickest planting, the yield per acre increases with the increase in rate of planting. For three kernels per hill the maximum yield is from hills three feet apart each way and the minimum from hills 3 ft. 8 in. apart each way. For four kernels per hill the maximum yield is from hills 3 ft. 8 in. by 3 ft., with but slight decrease for either of the other two distances.

Using only the medium maturing varieties there was an average yield of 64.3 bu. per acre from eight plats, planted at the rate of less than ten thousand kernels; from eight plats planted at the rate of eleven to thirteen thousand, 68.9 bu.; from ten plats planted at the

YIELDS FROM PLATS OF THE SAME SIZE PLANTED WITH CORN IN HILLS AT DIFFERENT DISTANCES APART, AND WITH A VARYING NUMBER OF KERNELS TO THE HILL, 1891.

Plat........	Variety.	Distance between hills, feet and inches.	Kernels per hill....	Ratio of stalks grown to kernels planted.	Per cent of barren stalks........	Number per acre,			Weight of 100 ears in lb..........	Yield per acre, bu. (70 lb. per bu.)...
						Kernels planted.	Stalks grown.	Ears harvested.		
1	Burr's white....	3-8′x3-8′	4	82	9	12,960	10,600	8,840	55.9	70.6
2	"	" "	4	81	9	12,960	10,480	8,840	58.6	74
3	"	" "	3	93	9	9,720	9,120	7,920	57.5	65.1
4	"	" "	3	93	11	9,720	9,080	8,080	58.7	67.9
19	"	3-8′x 3	4	68	6	15,840	10,804	8,849	53.1	67.2
20	"	" "	4	74	7	15,840	11,782	10,267	50.6	74.2
21	"	" "	3	87	10	11,880	10,364	8,898	55.1	70
22	"	" "	3	89	9	11,880	10,658	8,849	56	70.9
23	"	3 x 3	3	78	6	14,520	11,362	9,927	52.4	74.3
24	"	" "	3	81	9	14,520	11,720	9,867	49	69.2
25	"	" "	4	78	12	19,360	15,249	12,020	44.7	76.9
26	"	" "	4	78	15	19,360	15,069	12,139	37.5	65.1
31	"	" "	3	95	14	14,520	13,873	9,807	55	77.1
32	"	" "	3	81	7	14,520	11,780	9,927	53.8	76.5
33	"	" "	2	95	6	9,680	9,209	7,654	66.4	72.6
34	"	" "	2	87	3	9,680	8,432	7,116	66.6	67.6
35	"	" "	2	68	1	9,680	6,578	5,860	62.5	52.3
36	"	" "	2	84	1.5	9,680	8,133	7,834	58.2	65.1
5	Leaming........	3-8′x3-8′	4	80	8	12,960	10,440	9,320	46.2	61.5
6	"	" "	4	85	8	12,960	11,120	10,480	47.9	71.8
7	"	" "	3	88	7	9,720	8,560	8,160	53.7	62.7
8	"	" "	3	89	8	9,720	8,720	8,280	51.9	61.4
15	"	3-8′x 3	4	79	12	15,840	12,613	10,804	42.9	66.4
16	"	" "	4	82	8	15,840	13,004	12,076	44.3	76.4
17	"	" "	3	80	6	11,880	9,533	8,800	51.8	65.1
18	"	" "	3	84	4	11,880	10,071	9,436	49.7	67
27	"	3 x 3	3	85	11	14,520	12,438	10,166	49.2	71.5
28	"	" "	3	85	14	14,520	12,498	10,584	44.5	67.2
29	"	" "	4	80	14	19,360	15,548	12,498	39.5	70.7
30	"	" "	4	77	12	19,360	14,890	12,199	36.8	64.3
9	Early Butler....	3-8′x3-8′	5	66	10	16,200	10,760	9,800	35.1	49.1
10	"	" "	5	66	9	16,200	10,720	10,360	34.3	51.4
11	"	3-8′x 3	4	71	11	15,840	11,342	10,022	34.1	48.8
12	"	" "	4	70	9	15,840	11,098	10,364	37	54.8
13	"	" "	3	85	4	11,880	10,071	8,849	37.4	48
14	"	" "	3	81	4	11,880	9,631	9,093	39.8	51.7

rate of fourteen to sixteen thousand, 72 bu.; and from four plats planted at the rate of about nineteen thousand kernels per acre, 69.2 bu.

This single experiment showed a slight increase in yield from planting two or three thousand kernels per acre more than when four kernels per hill are planted in hills 3 ft. 8 in. apart each way, but the increased labor in harvesting the larger number of ears may partially if not wholly, counterbalance the small gain.

AVERAGE YIELDS OF CORN FROM SIX GROUPS OF PLATS, FOUR IN EACH GROUP, PLANTED AT DIFFERENT RATES, 1891.

Varieties, Leaming and Burr's white.	Distance between hills, feet and inches.	Kernels per hill....	Ratio of stalks grown to kernels planted.	Per cent of barren stalks..........	Numbers per acre.			Weight of 100 ears in lb..........	Yield per acre, bu. (70 lb. per bu.)...
					Kernels planted.	Stalks grown.	Ears harvested.		
Av. of 4 plats, 2 L. & 2 B.-w..	3-8′x3-8′	4	82	8.5	12,960	10,660	9,370	52.1	69.5
" " " " ..	" "	3	90	9	9,720	8,870	8,110	55.4	64.3
" " " " ..	3-8′x 3	4	76	8	15,840	12,051	10,499	47.7	71
" " " " ..	" "	3	85	7	11,880	10,156	8,996	53.1	68.2
" " " " ..	3 x 3	4	78	13	19,360	15,189	12,214	39.9	69.2
" " " " ..	" "	3	82	10	14,520	12,004	10,136	48.8	70.5

Experiment No. 6. Corn, Planting in Hills or Drills.

A tract of fall-plowed land, which had been in wheat in 1890, was planted May 18th with Burr's white, a part being planted in hills, 3 ft. 8 in. apart each way, and part in drills, the rows being the same distance apart, the intention being to drop one kernel each 12 inches. The planting was done with an ordinary check rowing planter with a drilling attachment.

The plats had like treatment, each being cultivated three times. The land was cultivated only one way. They were husked Oct. 22d, and the yields were exactly the same, 71.8 bu. per acre.

In 1890 there was a considerably larger yield from the corn in hills than from that in drills, and more when the corn in hills was cultivated both ways than when cultivated but one way.

Experiment No. 7. Corn, Effect of Depth of Plowing.

May 16, 1891, three equal and adjacent plats were plowed as nearly as possible at depths of 2, 5 and 10 inches and planted to corn. Oct. 23d, when harvested, they yielded, respectively, 54, 57.5, and 56 bu. per acre. The difference in yield was so slight that it cannot be said with confidence that the difference in the depth of plowing caused it.

In 1890 the yields from five adjacent plats, with seed-bed stirred to different depths, were as follows: Not plowed (disked shallow), 56.4; plowed 2 in., 59.9; plowed 4 in., 69.4; plowed 6 in., 69.3; plowed 8 in., 71.7 bu. per acre. None of these plats had any cultivation after planting, except removing the weeds by scraping the surface with a sharp hoe.

Experiment No. 9. Corn, Depth of Cultivation.

The tract used in this experiment was in corn in 1890 and was fall-plowed.

May 15th it was disked and harrowed, marked in rows 3 ft. 8 in. apart each way, and planted with Burr's white corn, four kernels per hill. The corn was dropped by hand and covered with a hoe. The tract was divided into four plats each 9x101 hills.

Plat 1 was cultivated shallow three times; plat 2, deep three times; and plat 3, deep once and shallow twice. The cultivation of the three plats was on the same days. After the last cultivation the weeds remaining were removed with a hoe. Plat 4 was uncultivated except by scraping the surface with a sharp hoe to remove weeds.

Oct. 23d the corn of each plat was husked and weighed separately, with the following results:

YIELDS OF CORN ON PLATS DIFFERENTLY CULTIVATED, 1891.

Plat No.	Kind of cultivation.	Corn per plat, lb. when husked.	Yield per acre, bu., (70 lb. per bu.)
1	Shallow	1,148	58.4
2	Deep	1,247	63.4
3	Deep and shallow	1,252	63.7
4	No cultivation	1,087.5	55.3

This experiment has been conducted for four years, and, using only the data for shallow, deep, and no cultivation, we have as follows:

YIELDS OF CORN ON PLATS DIFFERENTLY CULTIVATED, 1888-1891.

Kind of cultivation.	Bushels per acre.				
	1888.	1889.	1890.	1891.	Average.
Shallow, ordinary	93.8	84.6	66.8	58.4	75.9
Deep, ordinary	84.9	74.2	60.8	63.4	70.8
None, weeds scraped from surface	90	77.1	69.1	55.3	72.9

For each year, except 1891, the yields from the plats with deep cultivation have been inferior to those from plats with either shallow or no cultivation. The average for the four years shows the same result. In the deep cultivation for 1891 the "Daisy" cultivator, having small spring shovels, was used; while in each of the three preceding years the ordinary large shovel cultivators were used. The plat which had no cultivation in 1891 may have been somewhat affected by a row of trees.

Experiment No. 10. Corn, Effect of Root-pruning.

Every alternate row of eighteen rows two rods long, of each of the four plats described in experiment number 9, was root-pruned three times from June 19th to July 10th, to a depth of four inches. The pruning was done by placing around each hill a frame twelve inches square on the outside and passing around its outer edge a gaged knife.

Up to the time of tasseling the effect of root-pruning was marked, the pruned rows being noticeably smaller than the unpruned ones; but after the tasseling the effect was less apparent. Oct. 17th and 19th the corn for each row of each plat was husked and weighed separately, with the results given in the following table:

EFFECT OF ROOT-PRUNING UPON YIELD OF CORN, 1891.

Row.	Yield of ear corn, pounds.					
	Plat 1.	Plat 2.	Plat 3.	Plat 4.	Sum of 4 plats.	Yield per acre bu. (70 lb.)
1 Pruned	12.25	9.5	12	5	38.75	49.8
2 Unpruned	13.5	21	15	14	63.5	81.6
3 Pruned	8.5	12.25	11	6.5	38.25	49.2
4 Unpruned	11.5	14.5	14.5	13.5	54	69.4
5 Pruned	10	10	10.5	8	38.5	49.5
6 Unpruned	13	16.5	18	14.5	62	79.7
7 Pruned	10.5	10.5	10.5	7.5	39	50.1
8 Unpruned	14	15	15.5	15.5	60	77.1
9 Pruned	8	9.5	10	9.5	37	47.6
10 Unpruned	13	14	13.5	12	52.5	67.5
11 Pruned	10.5	12.5	11	9.5	43.5	55.9
12 Unpruned	15.5	17	14	13	59.5	76.5
13 Pruned	8.5	11.5	9	8	37	47.6
14 Unpruned	15.5	13.5	14.5	13.5	57	73.3
15 Pruned	8.5	11.5	9.5	7.5	37	47.6
16 Unpruned	12.5	14.5	14.5	9	50.5	64.9
17 Pruned	8.5	10.75	9.5	8	36.75	47.2
18 Unpruned	14	13	14.5	11	52.5	67.5
Total Pruned	85.25	98	93	69.5	345.75	49.4
Total Unpruned	122.5	13.9	134	116	511.5	73.1

In the above table are given 72 weights, involving 36 comparisons, every one of which is in favor of the unpruned. Reducing to acres and bushels, we find the average decrease per acre due to root-pruning to be 24 bu., or 32 per cent. The least average difference per acre for any plat was 21.3 bu.; the greatest, 26.6 bu. The least average difference of two rows for the four plats was 17 bu. per acre; the greatest, 32. With such results it is conclusive that the difference in yield is due to the root-pruning.

In 1888 the root-pruning was to the depth of three inches; in each of the following years, to the depth of four inches. The decrease from the more shallow pruning was very much less than from the deeper pruning of the other years. The decrease was greatest in 1891, the year with the least rainfall during the growing season; and next greatest in 1890, in which year the rainfall was also deficient.

EFFECT OF ROOT-PRUNING UPON YIELD OF CORN, 1888, 1889, 1890, 1891.

Kind of cultivation.	1888.			1889.			1890.			1891.		
	Unpruned..	Pruned....	Differences.	Unpruned..	Pruned....	Differences.	Unpruned..	Pruned....	Differences.	Unpruned..	Pruned....	Differences.
Shallow, ordinary	97	91	6	90.9	78.3	12.6	78.7	55	23.7	70	48.7	21.3
Deep, ordinary	87	83.2	3.8	80.9	67.6	13.3	70.8	50.7	20.1	79.4	56	23.4
None, weeds scraped off	94	85.5	8.5	85.8	68.4	17.4	76.7	61.5	15.2	66.3	39.7	26.6
Averages	92.7	86.6	6.1	85.9	71.4	14.4	75.4	55.7	19.7	71.9	48.1	23.8

Experiment No. 11. Effect of Fertilizers on Corn.

As stated in former bulletins, no important effect on yield of corn has been produced by the application of any of the more common forms of artificial manures to the fertile prairie lands on the University farms. The application of stable manure has, almost without exception, increased the yield, but not in all cases enough to repay directly the outlay. These results have little bearing on the effect of any kind of manure on less fertile lands, or even on naturally fertile soils after they have been cropped a long series of years without manuring.

For three years experiments have been tried at different points in this state, about on the latitude of St. Louis, in the light-colored soil of that region. Owing to unfavorable conditions—drouth and storms—or to injuries by insects, the results have been very unsatisfactory. The effect of applying stable manure has been uniformly good. With regard to the use of commercial fertilizers the experiments have not been conclusive, for the reasons given; but the indications are that they have not increased the yield enough to repay their cost.

Experiment No. 90. Growth of the Corn Plant; Increase of its Dry Matter.

For three years observations have been made on the rate of growth and on the rate of increase of dry matter in the corn plant.

The results each year have shown that there is relatively very little dry matter in the corn plant in the early stages of its growth. When the plant has reached its full height there has been less than 50 per cent, and when the ears are in the soft milk stage there has been not more than 75 per cent as much dry matter in the whole plant as when it has fully matured. Loss of leaves and tassels may reduce the weight; otherwise the dry matter increases until the plant is fully mature.

For three years plats of corn have been cut for fodder at three different periods; as nearly as might be when the ears were in the milk stage, when they were nearly mature, and when the plant was fully ripened. In each year there was a noticeably less yield, both of the whole crop and of the grain, from the early harvested plats than from either of the others. The yield of corn has been largest from the fully ripened plats.

These experiments, and the feeding tests which have accompanied them, will be repeated and fully reported. Without taking into account palatibility and digestibility of the fodder at different periods, the three trials indicate that very early cutting of corn, either for dry fodder or for ensilage, involves an important loss of food; but convenience, danger of loss if the corn is left standing until fully mature, and other considerations will influence the decision as to the best time to harvest the crop

Experiment No. 134. Corn, Effect of Removing Tassels.

The tassels on alternate rows of four-tenths of an acre of Burr's white corn were removed as soon as they appeared. Each of the thirty rows was husked and weighed separately. The total difference between those having the tassels removed and those not removed was but one pound, thus showing no effect from removing tassels. In similar trials with sweet corn the yield was somewhat reduced when the tassels were removed.

Removing the tops by cutting them off above the ears just before the leaves began to turn brown had no appreciable effect upon the yield of grain.

GENERAL CONCLUSIONS AND SUGGESTIONS.

Central Illinois has a soil and climate admirably adapted to the production of good corn. On the grounds of the Agricultural Experiment Station the average yield for four successive years of all the medium maturing varieties tested has been 73 bushels of air-dry shelled corn per acre. These yields have been secured almost exclusively without manuring or unusual cost of cultivation.

The soil has great natural fertility; is easily worked; is loose and sufficiently porous to a considerable depth; has great capillary attraction. Applying stable manure, or adding to the store of vegetable matter by plowing under a clover or grass sod, usually increases the yield. Applying any of the artificial manures ordinarily used in this country, as a rule, produces little effect. Deep stirring of the soil in preparation for the crop is not necessary. Air, water, and the roots of the corn readily find their way into this soil, even if it has not been stirred. In times of drought the soil has a marvelous power of bringing moisture from the depths of the subsoil and retaining it for the use of plants.

The climate is of the best for the corn plant. A season of nearly five months, free from frosts, may be expected. The average summer temperature is high. There is much sunshine, and, usually, frequent showers give sufficient rainfall.

For this soil and climate the best guarantees of a good crop of corn seem to be: (1) A good variety. (2) A good stand. (3) Keeping the soil free from weeds with the least disturbance practicable of the roots. A low cost for the crop will depend mainly on the ability to secure these conditions without unnecessary expenditure of money or labor.

There are many excellent varieties in cultivation in Illinois. Usually it is unnecessary, often a serious mistake, to send to a distance and pay high prices for seed corn. The claims made for many varieties prominently advertised are greatly exaggerated. There is no variety that we can rely on to produce 100 bu. per acre of dry shelled corn with average good soil, season, and cultivation. No variety suitable for general cultivation in central Illinois will mature in 90 days. The best varieties tested at the Station have a union of several desirable qualities in a fair degree rather than any one good point developed to an extraordinary degree. No very early maturing variety has given a large yield. No variety with remarkably large ears has matured sufficiently early to be very desirable. Neither the yield nor the feeding value of a variety depends on the color or smoothness of the kernels.

The varieties which have given the best satisfaction at the Station have had, in good seasons, stalks averaging 8 to 10 ft. high, producing ears at a height of about four feet; good ears, averaging 9 to 10 in. long and 2 to 2½ in. in diameter; cobs, about one-half the diameter of the ear; from 14 to 20 rows of kernels, with as little space as possible between the rows; kernels well covering the butt and tip of the ear. A reasonable uniformity in the diameter of the ear until near the tip is desirable; but some of the best varieties taper considerably. The time of ripening of these varieties has been from Sept. 10th to Sept. 20th.

Failure to secure a sufficient number and a uniform distribution of stalks is one of the most common causes of poor yields of corn. Stalks and ears of the largest size are secured by planting a less number than is necessary to secure the largest yield. With the rows 3 ft. 8 in. apart, planting four kernels in a hill has given larger yields than a less number. The number of stalks being the same and their distribution uniform, and the land being kept equally free from weeds, there has been no material difference in yield between planting in hills and planting in drills. When the largest and most valuable yield of both grain and stalks is desired the planting should be at a rate of not less than one kernel each six inches in the row. Poor seed, poor preparation of the soil, failure to cover properly the seed, or injury by insects, birds, or squirrels, or in cultivation may reduce the number of stalks far below the number of kernels planted.

Planting by May 1st is safe practice, but does not insure a larger yield than planting ten days to two weeks later. Medium early planting, if the soil is stirred just before planting, may make less cultivation necessary afterwards than very early planting. Except when the soil is very dry, covering the seed well, one to two inches, is better than deeper covering.

In this soil the chief good from cultivation seems to be in killing the weeds rather than in loosening the soil. Injuring the roots of the plants should be avoided as far as possible. Cultivating four inches deep, within six to ten inches of the stalks, after they have made a fair growth, will destroy many of the roots. Shallow cultivation, if the work is equally well done, is better than deep cultivation. More frequent cultivation than is necessary to keep the surface loose and free from weeds is not profitable.

Cutting or husking corn before it is fairly mature causes loss; but letting the corn stand till fully mature may result in even greater loss, either from storms or from the greater cost of late harvesting, or from both causes combined. Probably the greatest food value per acre is secured, if either the grain or the stalks are to be fed early in the season, by planting early maturing varieties, even though the yield be less.

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All communications intended for the Station should be addressed, not to any person, but to the

AGRICULTURAL EXPERIMENT STATION, CHAMPAIGN, ILLINOIS.

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UNIVERSITY OF ILLINOIS,

Agricultural Experiment Station.

CHAMPAIGN, MAY, 1892.

BULLETIN NO. 21.

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HORTICULTURE; A GENERAL REPORT.

The purpose of this article is to present a brief sketch of much of our work in horticulture; and with the outline there is given some hint as to results either obtained or expected, and, in some cases, suggestions as to their applications.

More time than we have yet had must elapse before a great many of our experiments reach a stage at which it would be profitable to report upon them in full. As they reach completion, fuller reports will be made.

VARIETY TESTS.

For variety tests we have growing on our grounds at present 475 varieties of apple, 28 of pear, 40 of plum, 48 of cherry, 8 of peach, 15 of apricot, 2 of quince, 6 of gooseberry, 7 of currant, 120 of grape, 14 of blackberry, 30 of red and black raspberry, and 98 of strawberry.

Variety tests would be made of more value if introducers were compelled to have the stamp of an experiment station before sending out new things. As it is, they may or not, as they please, send things to a station to be tested. If tested and a report made, the report may be used or not, as suits the case. If favorable, it will almost certainly be used for all it is worth; if unfavorable, it will very likely be thrown into the waste basket.

Fruits.

Apples.— It is too soon to expect any definite results from the tree fruits that have been planted since the establishment of the Experiment Station in 1888. From the University apple orchard, planted twenty years ago, a few varieties of value might be added to the lists commonly recommended; possibly two to the list for market, and three or four others to the list for home use.

The apples for market would be Ned and Early Ripe. Ned has somewhat the appearance and quality of Minkler, but its season is from October to January; it came to us also under the names of creek and custard. Mr. Samuels of Kentucky called it Kentucky cream. Mr. Van Deman thought it might be Minkler, but it is not in season at the right time for that. The early ripe is similar in appearance, season and quality to the early harvest. Though not so free a bearer with us, it does not suffer so badly from scab. It is already fairly well known in many places.

For family use there would be Jefferis, Higby sweet, and Sharp's apple. The two former are somewhat known and deserve to be better known. Sharp's, apparently, is not known or described anywhere. The Higby sweet is in season from October to December; the other two, in September.

Grapes.—Among the grapes and berries there has been fruiting enough to make some acquaintance with varieties planted three or four years ago. In grapes, if we should advise only a single variety, it would still be Concord, because Concord has long and successfully stood the test. Worden would be a close second. It is somewhat like Concord, and the Concord is sometimes sent out under the name of Worden when the latter is ordered.

For one who desires a greater variety than is usually recommended by our horticultural societies, Moore's diamond, and some of Roger's varieties, as Brighton, and Massasoit deserve a place. Vergennes, Goethe, and Duchess are among the best keepers and may easily be had in good condition until the holidays.

Blackberries.—In blackberries nothing has so far been found to take the place of Snyder. The Wilson, Wilson jr., and Erie produce with us but few perfect berries. Early king and early harvest, both gone before the Snyder is ripe, are good in their place.

Black Raspberries.—Of black raspberries the Palmer seems the most desirable. It is more productive than the Gregg, of better quality, and nearly as large in berry.

Red Raspberries.—The Turner is still one of the best of the red raspberries for home use. Marlboro and Cuthbert are firmer and on that account better for shipment. Clarke, a rather new variety, is very promising. It seems to have more substance than either of the others and has borne well. In quality it is quite distinct from other varieties.

Schaffer's colossal yields well and presents a fine appearance on account of its large size.

VEGETABLES.

Beans.—Varieties of beans have been grown quite extensively. The greatest obstacle to the cultivation of beans, other than the Lima, is their liability to rust. Some of the varieties most highly praised by seedsmen rust so badly that in three years we have not been able to grow enough of them to get descriptions. A few of the worst are lazy wives, Indian chief, green flageolet, Yosemite wax. Among those rusting less are the Valentines, refugee, the soup beans as navy, etc., southern prolific. In general the tender podded or snap beans seem to rust worse than the others. The so called rust proof varieties sent out by different seed firms have not seemed noticeably more exempt from disease than other related varieties.

Sweet Corn.—All the varieties of sweet corn offered by leading seedsmen have been tested and full reports have been made in bulletins four, eight, and thirteen.

Pumpkins and Squashes.—Pumpkins and squashes have been grown under all the different names under which they could be found. Sometimes the same name has been applied to different things; but more frequently several different names are given either to the same variety or to those so similar that for all practical purposes there is no difference.

Among the bush or summer squashes there seems to be but little choice. None of them are of much value after ripening. There are several varieties classed as different simply on account of the difference in the form of the fruits; as for instance, white bush scallop and pine apple. Of the winter squashes the marrow under various names, as Boston marrow, etc., have seemed most desirable, because most productive, and they are of very good quality. The Hubbard, with us, has been a shy bearer. The most productive of the pumpkins has been Connecticut field. Those of best quality are Yokahama, a very distinct variety, sweet, tender and fine grained, sweet cheese or varieties closely related to it, Jonathan, and Tennessee sweet potato.

All the pumpkins and squashes grown in the north belong to two natural species, *Cucurbita pepo* and *C. maxima*. Most of the pumpkins belong to the former species, but Jonathan, Tennessee sweet potato, and all the so called mammoth pumpkins belong to *C. maxima*.

All the late squashes except vegetable marrow belong in the species *maxima*. All the summer squashes and vegetable marrow, Brazilian sugar, and a few others belong in the species *pepo*.

The best characters about the fruit for distinguishing the species are the stem and seeds. The seeds of *C. maxima* are much whiter and are usually larger than those of *C. pepo*. The stem of *C. maxima* is pithy or corky on the outside while the stem of *C. pepo* is very woody and hard. The stem of *C. maxima* is nearly round and enlarged, while that of *C. pepo* is strongly 5-angled. It would have been much better if the term pumpkin could have been applied exclusively to one species and squash to the other. It may not be worth while to try to change now.

WINTER PROTECTION OF PEACH TREES.

Turning down peach trees for winter protection has been tried somewhat and the trials are still going on. Results have been fairly favorable. To prepare for turning down the trees the best method is to plant them with the roots extending in two opposite directions. The roots can be bent, and if any are too large for that, cut them off close to the trunk of the tree. Then by digging the dirt away from one side the tree may be bent down, twisting the roots. Evergreen branches, corn stalks, or coarse straw make a good cover. The tree will not stay down unless fastened in some way.

The varieties of peach differ in hardiness. During the past winter the temperature fell to –12½° F. at one time and to –15° F. at another. An examination of the buds of six different varieties gave the following results:

Variety of Peach.	No. of buds examined.	No. of buds dead.	No. of buds alive.	Per cent of buds alive.
Alexander	121	79	42	34
Lemon cling	151	133	18	13
Roser	144	24	120	83
Thurber	192	62	130	67
Wager	172	157	15	8
Seedling cling	766	170	596	77

The above varieties were kept well cultivated during the entire season, and the treatment of all was the same. An unknown variety growing in sod had 95 per cent of its buds alive when examined at the same time.

We are starting to make a collection of all the varieties reputed exceptionally hardy and expect to grow seedlings from these. There is no reason why a few generations may not give us a peach hardy enough to stand most of our winters and as good in point of size and quality as those now grown. The trees can be covered, of course, and even the tender ones made to fruit; but if a hardy variety can be had, there is no need to cover up tender ones.

PROTECTION OF THE TRUNKS OF TREES.

We are trying methods of protecting the trunks of trees, in varieties where that seems to be the weak point, by the use of boards and building paper; by the growth of plants on the southwest, such as corn or the black raspberry; or by giving the tree a new trunk, as has been so long and ably advocated by Mr. J. V. Cotta, of Nursery, Ill. The piece which forms the new trunk retains its individual character, as may be seen by noticing the overgrowth of a fast growing variety when worked on one of slower growth.

CROSS FERTILIZING AND HYBRIDIZING.

Cross fertilizing and hybridizing have been carried on to some extent, both for the study of the effects of crossing and for the purpose of producing, if possible, new varieties of value. A number of crosses have been made in the apple, as for instance, between Ben Davis and Grimes, Ben Davis and Minkler, or Ben Davis and Duchess, with a view of getting something that will bear like the Ben Davis, but have the better quality of Grimes or Minkler; have the keeping quality of the Ben Davis and the hardiness of tree of the Duchess. Different varieties of strawberries have been crossed and plants are growing from the crossed seed. Blackberry varieties have been crossed, seeds planted and plants are growing. Raspberries have been crossed—black varieties together—red varieties together—black with red, and blackberries with raspberries. We have now ready for planting more than a quart of seed from crossed raspberry and blackberry or from selected varieties.

Results are problematical, but there is certainly great room for improvement in our blackberries and raspberries. There is entirely too much seed for the amount of flesh. When we consider that our apples originated from a crab in no way superior to many of our own native wild crabs, and the excellence that has been developed by cultivation and selection, what may we not expect from our raspberries and blackberries, which are so much better naturally? We have only begun with the raspberry and blackberry group of plants. I believe none of the blackberries or dewberries now cultivated are the result of growing plants from seed, but that all are the result of propagating natural seedlings; and it is not at all certain that we have yet the best of the wild varieties. Most of our raspberries are the result of chance.

During the past three seasons some work has been done in the line of crossing and selecting corn. The results seem to indicate that corn grown from crossing two distinct varieties will be larger than the average of the kinds crossed; or where the parents are nearly equal, larger than either.

It is not certain that this isolated fact, if it prove to be a fact, will be of any value to fruit growers; nor is it certain that the direct results of these corn crosses will yield anything of value in themselves.

There were shown at the last State Fair, samples of what are called Carter's cross-bred wheats. They are as wonderful in their way as the best specimens of the breeder's art among animals. Mr. John Thorpe, now at the head of the Floral Department for the World's Fair, who has been a successful originator of flowering plants, said he could come as near producing a desired variety by growing 100 plants from crossed seed as by growing 1,000 plants from seed simply selected. There is plenty of room for the skillful breeder of plants.

IMPROVEMENT OF NATIVE FRUITS.

We cannot have too much variety in the way of wholesome fruit.

Poor as our wild crabs are considered by many, a taste for them may be cultivated, the same as a taste for the Russian apples, or for tomatoes or celery. Most of the wild crabs seem to be abundant bearers, hardy, and comparatively free from disease.

There is promise of value in our papaw, (*Asimina triloba*).

In Japan the persimmon is their standard fruit. No reason is known why ours cannot be made fully equal to those grown in Japan. Even as they grow native they show a decided tendency to vary, and the best of them are certainly equal to the Japanese as sold in our markets. The persimmon of Japan has had the advantage of thousands of years of man's cultivation and selection.

There may be something worth looking after in our red haws (*Cratægus coccinea*). Some of them are now gathered for jelly and butter.

We have seedlings of all these wild fruits growing and should be glad to get more seeds or cions of exceptionally good kinds. There seems to have been no continued attempt to improve any of them. They all, even in their wild state, vary in shape, size, season and quality. Cultivation ought after a few generations to bring out or strengthen good points. On the side of producing new varieties, we do not know of a more promising field than our native wild fruits. We have many promising varieties of native plums—all or nearly all chance or natural seedlings. Our grapes have been made much of, though the Concord, which still heads the list for general purposes, was a wild seedling of the New England woods. We may hope, however, that the Concord will not long hold its sway; for there are nursery-grown seedlings, crosses and hybrids, which are fast coming to the front, and we may expect the old standard to be superseded by something as hardy, as productive, of finer appearance and better quality. Will not the variations of later generations from Roger's hybrids give us something of value? To be sure nothing has yet been reported in that line, though there would seem to have been abundant time for seedlings to have been grown. If the results of our crosses in corn are to serve as an index, we might expect to find in a second or third generation fruit of the *Vinifera* type on vines of the *Labrusca.* There is a great difference in the susceptibility of fruits to the influence of man. Our grapes have had more time spent on them, extending over a longer period, than have our strawberries; yet the results from grapes are hardly to be compared to the results with strawberries.

A small start has been made in the growth of nuts. The attempts at improvement heretofore have been confined almost exclusively to the pecan and chestnut. Attempts at improvement by growing seedlings from the best native trees have usually been a disappointment, because the seedlings have been inferior to the tree from which seed was taken, just as 999 of every 1,000 seedlings grown from the Concord grape have been so inferior to the parent as to be unworthy of general distribution. But it must be remembered that while there are comparatively few chances for improvement by growing seedlings there are none from simply budding or grafting.

The filbert and walnut of Europe are too tender for our climate. Why may not our hazel-nut and walnut be improved so as to take their places, and be made valuable crops for the rough lands along our streams?

METHODS OF CULTIVATION.

Grapes.—Since the spring of 1888 a cultivation experiment has been carried on in an old vineyard on the University farm. Part of the vineyard has been kept well cultivated, while the rest is allowed to grow up to weeds and grass, and is mowed over two or three times during the season. During the seasons of 1888 to 1890 no attention was paid to comparative yield, because so large a proportion of the fruit rotted that it seemed undesirable to make comparisons of yield. For 1891 the yield per vine of grapes not cultivated was 17.67 lb. while on vines kept well cultivated the yield was 10.89 lb. per vine. But the vines made a much more vigorous healthy growth where well cultivated than where not and are in better condition for next year's work. The bunches on the cultivated vines were larger and the berries larger, better colored, better flavored, earlier (at least 10 days) and ripened more evenly, than on the vines not cultivated. Pound for pound they were worth nearly twice as much in market, because they were earlier and because they presented a better appearance.

Raspberries.--It is not necessary to tell the practical, progressive fruit grower that it pays to give all crops thorough cultivation. But many farmers and a few fruit growers seem to think it is necessary to cultivate raspberries the first year only; the only attention needed thereafter being to pick the fruit when ripe. With such treatment the plants are not usually worth much after the third or fourth year. With good care the black raspberry plat ought to improve with each year for at least four years, and then last indefinitely. All our raspberries have been cultivated more or less, but some of our neighbors have had plats which were not cultivated the past season. One of them, when asked last summer about his berries, said "I am picking dried raspberries and expected to be able to supply the home demand." A plat of our Gregg raspberries that has been cultivated after the fruiting season only, having the weeds mowed off before the fruit ripened, was as good as the same variety on the grounds of any fruit grower visited during the season. Alongside this plat was another of the same size, kept well tended during the season, which yielded nearly twice as much as the one only half cultivated, the yields being 272½ qt. and 487½ qt. Although the season was very unfavorable, several growers who visited us said they had never before seen so fine a plat of black raspberries.

Farmers sometimes say when urged to keep better stock, "The improved breeds take more attention to keep them in condition;" or, "The scrubs would be nearly as good as the improved breeds, if as well cared for." There is a half truth in both statements. A similar thing could be said of our fruits. It is care that has made them larger, more productive and improved their quality. Without this same care continued they would tend to revert to their original condition.

FUNGICIDES.

Fungicides have been tried for preventing black rot and mildew of the grape, scab of the apple, leaf blight of the potato, etc. A report of this work has been published in bulletin No. 15, and also in the last report of the State Horticultural Society. We are still experimenting.

There are other uses for both fungus and insect remedies besides saving the crop of fruit. Any disease which attacks the leaves or branches lowers the plant's vitality, causes a less perfect ripening of the year's growth, and, consequently, greater inability to withstand the effects of severe winters. If the apple trees had been in perfect health a few years ago there is no doubt we should have heard much less of the test winters of the early '80's.

WHOLE AND PIECE ROOT GRAFTING.

A study of whole- and piece-root grafting has been begun. For this purpose something more than 2,000 grafts were put up here and were set last spring, though many of them failed to grow.

The principal advocates of the whole-root method claim as its greatest advantage that the graft is set on the collar of the seedling tree, that there alone is the natural place for a union between the trunk of the tree and the root, and that to put the graft on any other part of the root must necessarily make a less perfect union, and, consequently, a poorer tree in the nursery, and a less enduring and perfect orchard tree. They do not advocate the use of the whole root as one would naturally be led to suppose; but what is usually called the upper cut, five to six inches long, from the collar down. We have used roots in the following forms:

Roots ten inches long with the cion set two inches above the collar, on the collar, and two inches below the collar.

Roots cut into two pieces each five inches long, being careful to put the cion in the collar of the upper cut.

Roots cut and cions put in the same as the last, but leaving the side branches on the root.

Roots cut into three pieces each four inches long, again putting the cion on the collar of the upper cut.

In like manner the roots were cut into bits two inches and one inch long.

The conclusions from one year's work are:

The whole root has no advantage over a piece root of the same size. (Size refers to both length and thickness.)

Roots with the small side branches left on gave better results than roots of the same size, with the rootlets cut away.

Roots five inches long gave better results than roots four inches, two inches, or one inch long.

Roots five inches long not trimmed gave nearly as good results as roots ten inches long.

BOTANICAL WORK AFFECTING HORTICULTURE.

The Botanist and his assistant are endeavoring to gain new information upon every opportunity, by observation, experiment, and research.

Much of this work must depend upon opportunities as they arise, such as observations upon special diseases when they appear, and any peculiarities of plant development when they are found. But special subjects are selected upon which work is done more or less continuously. Just now those in hand directly allied to horticulture are:

1. An investigation of the structural physiological union of stock and cion and of modifications observed in different unions.
2. The cause of the disease known as "yellows of the peach tree." A large amount of work has been done by the Department of Agriculture, at Washington, but no definite conclusions have been reached as to the immediate cause. While the disease does but little, if any, damage in this state, it has been very serious in other states.
3. The life history and peculiarities of development of the red rust of blackberries and raspberries.
4. Potato scab. We have during several years made investigations on this peculiar disease and in common with other recent observers have found clear evidence that it is due to a bacterial parasite. Other stations have gone somewhat farther in some lines and have shown that diseased seed carries to the new crop germs of the disease; that the disease may be retained in the ground from year to year; that treating seed with solutions of corrosive sublimate or the copper solutions tends to check the disease, or that spraying the seed potatoes in the furrow just after planting tends to prevent the disease.

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G. W. MCCLUER, B.S., *Assistant Horticulturist.*

CORN CROSSING.

The systematic breeding of plants is one of the comparatively new things, followed by but few, and of which but little is commonly known, either as to methods or results.

Among the more advanced florists plant breeding, crossing, and hybridizing have been carried on longer and more successfully than among farmers or fruit growers; and the many valuable varieties of flowering plants which have been produced are abundant evidence of the efficacy of skillful work on these lines; but to the great majority of florists such work has been a hidden mystery. A few farmers have attempted to produce better varieties of corn and other plants by crossing: they have done much more by continued careful selection; but outside of experiment stations there has been very little work done and recorded in the way of breeding new varieties of corn, wheat, or oats.

Mr. Carter, of England, and Mr. Carman, of the *Rural New Yorker*, seem to have been the pioneers in crossing or breeding wheats. (The term "breeding" is used here to impress the analogy between rearing plants and animals, for while there are many obvious points of difference there are many points of resemblance. There must in every case, either plant or animal, except in some very low forms, be male and female, and for reproduction in plants as in animals the male and female elements must be brought together; and the parentage of the coming plant can be controlled just as certainly as the parentage of the coming animal.) The pioneer in oats breeding has not yet made himself known. The breeders of corn are not prolific writers and so are not well known.

The work done at the various experiment stations has not yet been well digested. In fact there has scarcely been time for the accumulation of sufficient data from which to make well digested reports. Some of the stations seem to have gone only far enough to study the immediate results of crossing; that is, the effect of the pollen, or male element, on the resulting kernel of corn, making the work in that sense scientific only, as distinguished from the practical. An object with other stations has been the production of varieties which should show points of superiority for the special locality over varieties already grown. In this line Minnesota reported apparent success; but just as success was reached, a fire in their barns destroyed all the seed. If, however, they have kept full notes, and these were saved, they can begin again where they were at the start and reproduce the same variety with much less labor than before, because there will be no need of more than the work leading to the special result.

The work which forms the basis of this report on crossing corn was begun in 1889. Crossing the dent corns, to which reference is made, was done by Professor Thos. F. Hunt, now of Ohio State University, who was at that time assistant agriculturist here.

During this first year, 16 ears were produced by crossing varieties of dent corn, no crosses being made between varieties of different colors. Besides the purely dent corn crosses there were made the following:

Male, or pollen-bearing parent.	Female, or ear-bearing parent.	Ears produced
Leaming [yellow dent]	Mammoth [sweet]	4
''	Triumph ''	3
''	8-rowed ''	3
Gold coin [yellow sweet]	Mammoth ''	2
''	Triumph ''	3
''	8-rowed ''	2
Stowell's evergreen [sweet]	Mammoth ''	2
''	Triumph ''	3
''	8-rowed ''	4
Queen's golden [pop-corn]	A white dent	2
A white dent	Queen's golden (pop-corn)	2
Black Mexican [sweet]	''	3
''	A white dent	3

During the season of 1890, 158 ears were produced by crosses between different varieties, or by crossing different stalks within the same variety, or by self-fertilizing, that is, by using the pollen of a stalk on silks of the same stalk. The crosses of varieties different from those of the previous year were:

Male parent.	Female parent.	Ears produced.
Gold coin [sweet]	Brazilian flour	2
Queen's golden [pop-corn]	Common pearl [pop-corn]	4
Brazilian flour	Burr's white dent	2
White dent varieties	Yellow dent varieties	6
Yellow dent ''	White dent ''	3

In none of the crosses between different varieties of dent corn of the same color, or between different varieties of sweet corn of the same color, has there been any change in the crossed ear that could with any certainty be attributed to the pollen. While ears produced by crossing different varieties have varied from each other, and from the type of the variety, they have only varied in the same directions and apparently to no greater extent than ears of the same variety left to form naturally. The typical ear of the Stowell's evergreen differs very decidedly from typical ears of either 8-rowed, triumph, or mammoth; but the ears produced by pollen of Stowell's on either of the others did not differ from the female type in any way, more than did many ears left to be fertilized naturally. It is possible that the pollen of a very smooth dent corn on the silks of a very rough dent variety would tend strongly to make the resulting ears smoother, but the opposite cross would scarcely tend to make the resulting ears rougher.

Ears produced by crossing white sweet corn with pollen of yellow dent corn have been nearly as dark as the male variety, with kernels very much like flint corn in appearance, neither dented nor wrinkled, and with the taste characteristic of dent corn. The kernels are probably increased in size, at least the seed-coat is not shriveled as is characteristic of sweet corn. The change in form of the seed coat is probably an indication that the kernel has stored more dry matter in proportion to water than it would have done had it been fertilized with pollen of sweet corn. Where both sweet and dent kernels appear on the same ear the dent kernels are always the heavier. Kernels were weighed from five ears, each of which had both dent and sweet kernels with the following results:

		Wt. in grams of 100 kernels.
Ear No. 1	Sweet kernels	27.9
	Dent "	34.5
Ear No. 2	Sweet kernels	23.4
	Dent "	29.5
Ear No. 3	Sweet kernels	39.2
	Dent "	47.4
Ear No. 4	Sweet kernels	22.6
	Dent "	27
Ear No. 5	Sweet kernels	26.4
	Dent "	34.8

Color, where it is a character of the kernel and not of the seed-coat, tends very strongly to pass from one variety to another. The peculiar color of the cranberry did not seem to affect the other white varieties to which the pollen was applied. The cranberry owes its color to the seed-coat entirely; the kernel is white, and the variety is classed as a white corn. In the white, yellow, and black varieties and in crosses of these, which run into other colors, the color is determined by the kernel and not by the seed-coat.

Ears produced by crossing yellow dent corn with pollen of white dent have been lighter colored, and those produced by the opposite cross darker colored than the type of the female parent, though the change has not always been uniform.

Ears produced by crossing Queen's golden pop-corn with pollen of black Mexican sweet corn showed the black color in varying degrees in most of the kernels, but were otherwise unchanged.

Ears produced by crossing a white dent with pollen of black Mexican had kernels varying in color from white to black. More than half the kernels were wrinkled and had the taste characteristic of sweet corn ; while the rest, though showing the black color as much as the wrinkled or sweet kernels, were only less dented than is characteristic of the variety. The taste was not modified.

Ears produced by crossing Brazilian flour corn with pollen of gold coin sweet corn were nearly as yellow as the gold coin, and the kernels were flinty in outward appearance.

Ears produced by crossing Burr's white dent with pollen of the Brazilian flour corn showed no positive results of the cross.

Ears produced by crossing white sweet corn with pollen of yellow sweet corn were nearly as yellow as the pollen-bearing variety.

Ears produced by crossing white dent with pollen of Queen's golden pop-corn were nearly as dark as the pollen-bearing parent, and were less dented than is characteristic of the variety. The smoothness may or may not have been an effect of crossing.

Ears produced by crossing Queen's golden with pollen of white dent seemed lighter in color but were otherwise unchanged. Though the kernels of the dent corn weigh nearly two and one-half times as much as the pop-corn the pollen of the dent corn seemed to make no difference in the size of pop-corn kernels.

Ears produced by crossing the white pop-corn, common pearl, with pollen of Queen's golden were very strongly marked with the yellow color of the male parent.

One of the principal things to be learned from making some of these crosses of widely different varieties is the degree of certainty which can be felt in the work done. For this purpose the crosses in which yellow dent has been the male and white sweet varieties the female, yellow sweet male and white sweet female, and yellow pop-corn male and white dent female have been the best. On nineteen ears produced by these various crosses there were found only two kernels which did not show distinctly the effects of the pollen, and these two kernels were pretty certainly not fertilized with the pollen intended. In the case of sweet corn stalks bearing two ears, where only one was crossed and the other left to be naturally fertilized, there was no indication of anything but sweet corn pollen on the naturally fertilized ears.

The results obtained from planting crossed seed have been of more importance than the immediate effect of crossing, not so much in themselves perhaps as in the conclusions which may be drawn from them. None of the purely dent corn crosses have been used for seed. If they had been, some of the conclusions drawn from growing the others might have been modified. Parts of most of the ears produced by the other crosses were planted in small plats, one by two rods, with but little space between them. During the first growing season the uniformity of the crossed plats was very noticeable. Of 142 plats planted with sweet corn, pop-corn, and these crosses, it is safe to say there was as much uniformity in any one of the crossed plats as in any, and very much more than was found in most, of the plats planted with pure varieties.

The plats in which Leaming was used as the male parent resembles decidedly that variety.

The plat in which the white dent was the male and Queen's golden female resembled the dent; while the opposite cross, Queen's golden male and white dent female, produced a plat intermediate between the two parents in character.

The plats from seed produced by using the black Mexican as male and the white dent as female parent, resembled decidedly the dent corn.

The plat planted from the gold coin-flour corn cross, produced stalks more like the common dent corn than like either parent. While the gold coin occasionally produces suckers and the flour corn characteristically two to four or more, each of which reaches nearly the size of the parent stalk, the stalks from crossed seed produced no suckers.

The stalks from Queen's golden-pearl pop-corn cross were in type between the parents but larger than an average size of the two.

The number of rows of kernels on the ear seemed to be modified about equally by each parent. The Leaming has 18 to 24 rows of kernels, and the mammoth sweet 12 to 16. The ears grown from the cross had from 14 to 18 rows. Both the 8-rowed sweet and triumph have 8 rows of kernels. The corn grown from the Leaming-8-rowed cross had 10 to 14 rows of kernels ; while those grown from the Leaming-triumph cross had from 10 to 16 rows.

The number of ears to the stalk tended to follow the same type as the stalk. As an illustration, the black Mexican corn usually produces one ear, sometimes two ; the pop-corn usually produces two-eared stalks, though frequently three-eared. The cross between the two varieties had very much the appearance of Queen's golden as it grew, and most of the stalks bore two ears, while a few bore three.

On these plats of crossed corn a large number of cross and self-fertilizations were made, though not going outside of the plat for the pollen used in the crossing. The ears so produced and other selected were used in the second year's planting.

When the crossed plats were husked the ears from each plat were as uniform as is common with varieties of corn. The corn grown from the crosses of different varieties was plainly modified to about the same extent by each parent. The corn produced by using the pop-corn and dent corn as parents seemed to show the effect of the male more than of the female parent, those in which the pop-corn was the male parent being more flinty than those in which the dent corn was the male parent.

Description of Plates.

Plate 1. Black Mexican-white dent cross.—Ear No. 1 is the type of the variety used as the male parent. No. 2 is the type of the variety used as the female parent. No. 3 shows the immediate result of the cross, corn from which was planted to produce 4 and 5. No. 4 is corn grown from the wrinkled, or sweet, kernels of No. 3. No. 5 is corn grown from the dent kernels of No. 3.

Plate 2. Queen's golden-common pearl cross, showing increase in size of cross-bred corn.—Ear No. 1. is the type of the variety used as the male parent. No. 2 is the type of the variety used as the female parent. No. 3 is corn grown from the cross between 1 and 2. The immediate result of the cross is not shown.

Plate 3. Leaming-triumph cross.—Ear No. 1 is the type of the variety used as the male parent. No. 2 is the type of the variety used as the female parent. No. 3 shows the immediate result of crossing. No. 4. corn grown from planting No. 3.

Plate 4. Corn grown the second year from the Leaming-mammoth cross.—Ears No. 1 and 2 are corn grown from yellow dent kernels. No. 3 and 4 are corn grown from white dent kernels. No. 5 and 6 are corn grown from sweet kernels. No. 1, 3, and 6 show ears most nearly approaching the general form of the Leaming. No. 2, 4 and 5 show ears most nearly approaching the general form of the mammoth sweet corn.

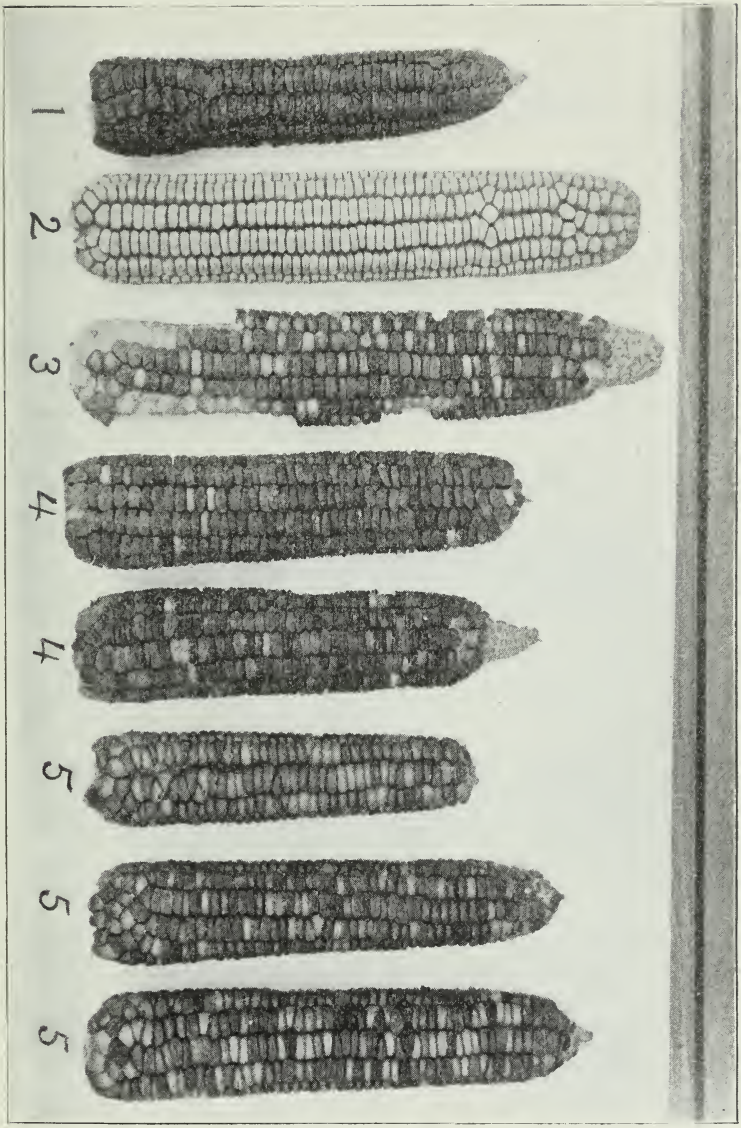
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PLATE NO. 2.

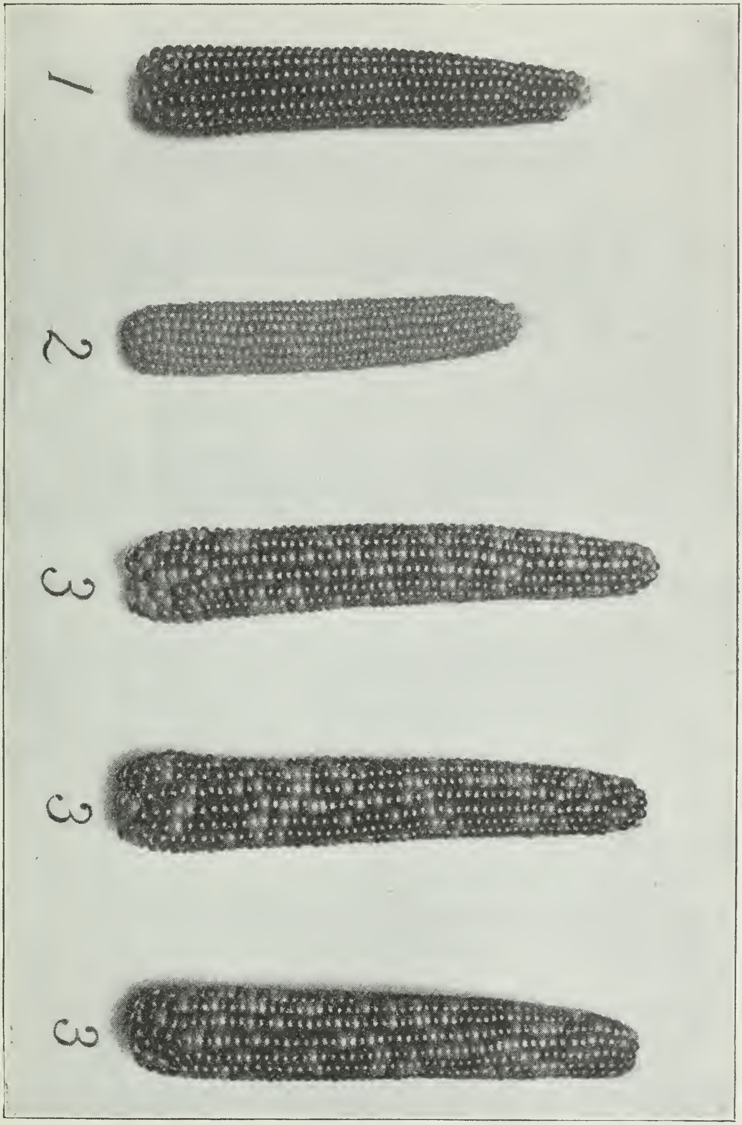
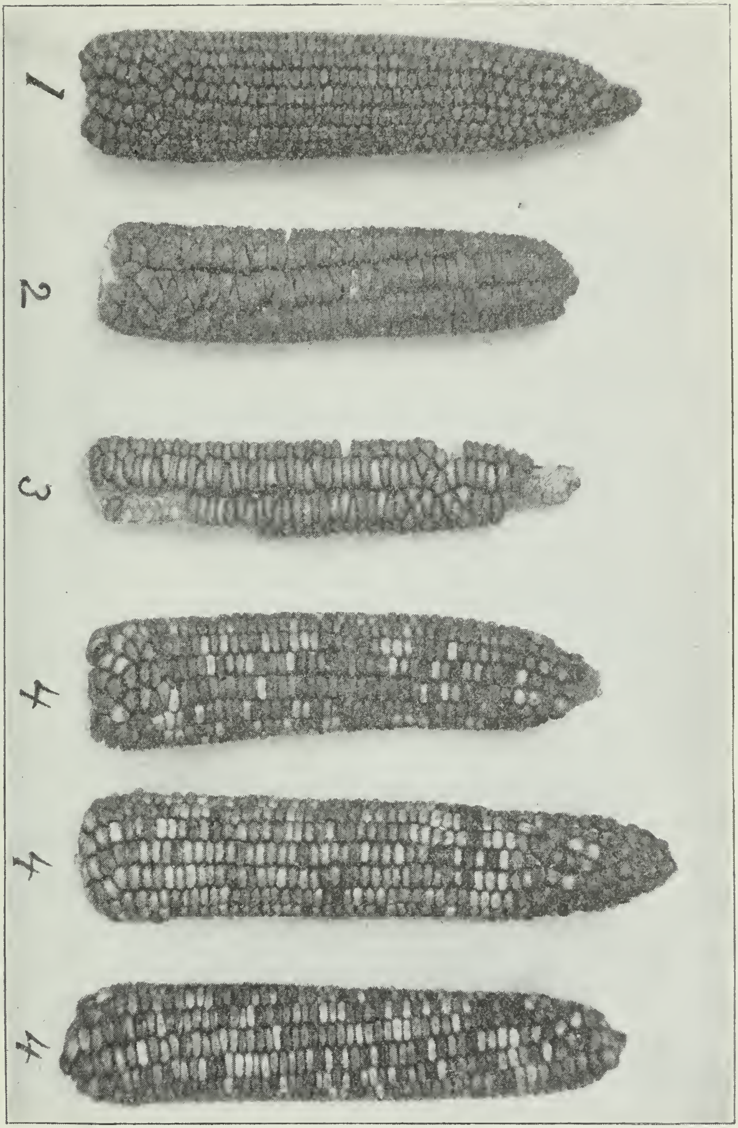
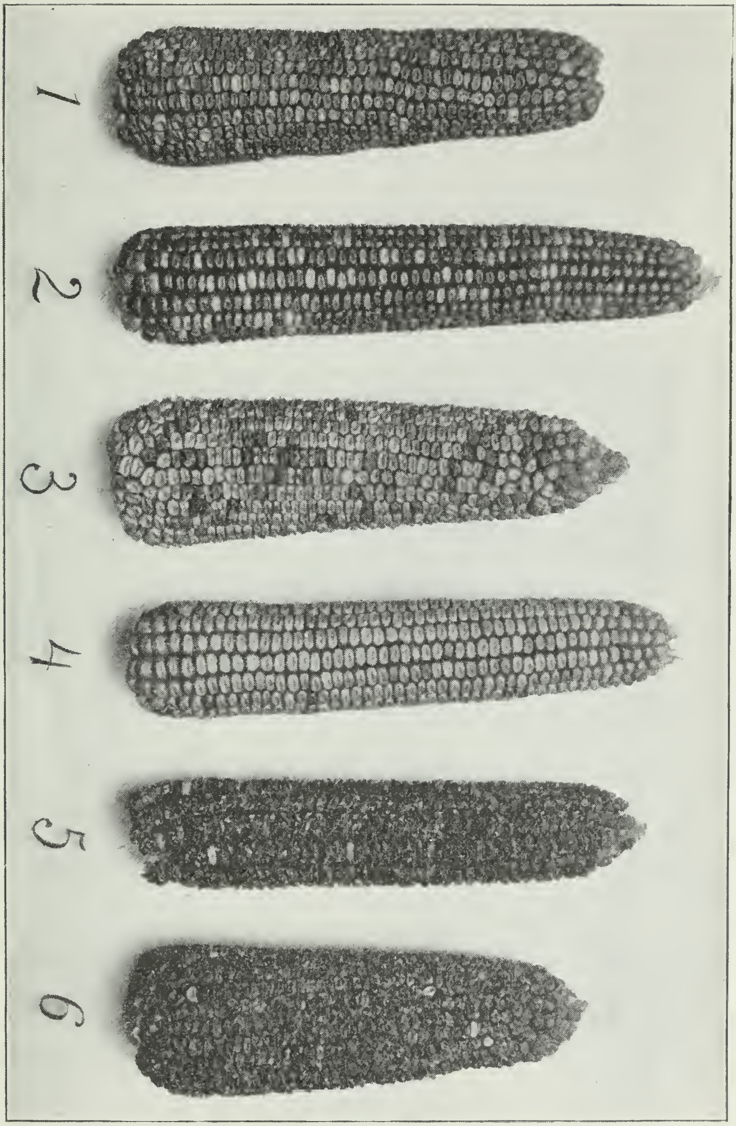


PLATE NO. 3.

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The corn grown from the cross between the black Mexican and Queen's golden seemed to be about equally modified by both parents, with kernels both flint and sweet and showing shades of all the primary colors and white besides. The corn grown from the cross between Leaming and the different varieties of sweet corn showed a modification of kernels similar to that found in the black Mexican-white dent cross at the beginning of the first generation ; but with a decided tendency of many ears toward the flint type, some of them going so far that, except for the sweet corn kernels in them, they might be taken as types of flint corn. The self-fertilized ears showed the same modification of kernels as those naturally fertilized, proving that each kernel of the crossed corn had in itself the power to produce both sweet and dent corn. There were comparatively few kernels in the corn grown from the crosses between dent and sweet corn that were not distinctly either sweet, or dent in character.

The sweet and dent kernels of the black Mexican-white dent cross were separated and planted in different plats. The result is well shown in plate 1, page 87, in which the ears numbered 4 were grown from sweet kernels and those numbered 5 grown from dent kernels, both taken from ear number 3 of the same plate.

The corn grown from the crossed seed was in nearly all cases clearly increased in size as a result of crossing, the cases in which the opposite result was reached, being the cross between black Mexican and white dent (which was grown in a place very unfavorable for it), and that between Stowell's and 8-rowed sweet. Plate 1 shows one of the instances of decrease of size while plates 2 and 3 show an increase of size. The ears shown as types of the varieties used in crossing are selected typical specimens of the varieties and the ears shown as grown from the crossed seed are typical of the cross-bred corn.

The table on page 97 will give a still further showing of results from the corn grown the first year after the cross and for the second also in cases where the corn has been grown a second year. The weights given are for thoroughly air-dry shelled corn. The yield of plats as a whole, are not given because estimates of yields from such small plats have heretofore been so very unsatisfactory. It is hoped that some of the work outlined may be done soon on a larger scale, so as to give more trustworthy results as to yield.

Corn grown from the crosses the second year has continued to be comparatively uniform in type where the parent varieties were similar; but where the parent varieties were widely different, as in the crosses between sweet and dent, the progeny has tended strongly to run back to the parent forms, while at the same time taking on other forms different from either. This is shown in part in plate 4, p. 93, which is made up of ears of the second generation from the Leaming-mammoth cross. The ears numbered one and two were grown from yellow dent kernels; those numbered three and four, from white dent kernels; and those numbered five and six from sweet kernels. The ears numbered one, three, and six approach in type of ear to the Leaming, while the rest of them are similar to the mammoth. There are many gradations between the two forms, and among the ears grown from the white or yellow dent kernels there are some which approach the flint corn type much more than ears 2 and 4 shown in the plate.

The black Mexican-Queen's golden and black Mexican-white dent crosses show still more variation in the second generation than is shown by the crosses of Leaming and sweet corn. The black Mexican-white dent cross showed but little tendency to run back to the dent type, but a strong tendency toward sweet and flint types.

Nearly all the corn grown a second year from the crosses is smaller than that grown the first year, though most of it is yet larger than the average size of the parent varieties. The cause of this apparent decrease in size, as compared with the previous year, can only be guessed at. It cannot be attributed to the season, because the Queen's golden-common pearl pop-corn and gold coin-flour corn crosses grown in 1891 show as large a proportionate increase in size of ear as is shown in any of the crosses grown in 1890. There is probably a strong natural tendency in the crosses to revert to the size as well as the form of the parent types. This is shown in the Leaming-sweet corn crosses in which the corn reverting to the dent is larger than that reverting to the sweet types. Or the loss of size may be due to a diminution in some way of the vigor imparted by crossing. Each plat being planted from a single ear there would necessarily be close inbreeding, which it is generally admitted tends to deterioration. That there was very little mixing of the corn in one plat with that in another is shown by the character of the corn grown from selected seed, which in very few cases showed anything different from the corn grown from seed which was artificially crossed and so known to be pure. Plats grown from self-fertilized seed were in most cases notably inferior in size and vigor to the plats grown from crossed seed or from seed simply selected. This is shown to some extent in the last column in the table on p. 97. (As used in the table the term means a cross between different stalks of the same plat and not as in the other case between different varieties.) The table does not give so convincing an illustration of the bad effects of self-fertilization as the plats themselves did when growing, or as the corn did when husked and thrown into piles. One plat from self-fertilized seed, had nearly half the stalks deformed in such manner that instead of standing up straight they turned off nearly at a right angle at or near the joint where the ear was produced, thus throwing the tassel on a level with or below the ear. Many of the tassels were very deficient in pollen. In another plat from self-fertilized seed nearly all the tassels were abortive. All the plats from self-fertilized seed produced a greater proportion of barren stalks and of poorly filled ears than the plats of the same varieties either from crossed seed or from

RESULTS FROM CROSSES OF CORN.

Cross.	Wt. 10 ears of the male variety.	Wt. of 10 ears of the female variety.	Ave. wt. 10 ears of the two parent varieties.	Wt. of 10 ears grown from cross the first year.	Wt. of 10 ears the second year after the cross, oz.
White dent-Queen's golden.	81	34.5	57.75	76	Ears like the dent type......64 Ears like the pop corn type.52.5
Queen's golden-white dent.	34.5	81	57.75	64	Ears like flint corn.........55 Ears like pop-corn type.....47.5
Black Mexican-Queen's golden......	36	34.5	35.25	47.5	Types not separated........43.5
Queen's golden-common pearl pop-corn.	34.5	27.5	31	42	Not grown a second year.
Leaming-mammoth	87.5	61.5	74.5	91	Corn grown from yel. dent k.86 Corn from white dent ker...90 Corn from sweet kernels....74
Leaming-mammoth	87.5	61.5	74.5	82	Not grown a second year.
Leaming-mammoth	87.5	61.5	74.5	80.5	Not grown a second year.
Leaming-triumph	87.5	46.5	67	83	Corn from dent kernels.....86 Corn from sweet kernels....68
Leaming-8-rowed	87.5	41	64.25	72	Corn from white dent ker...80 Corn from yellow dent ker..75 Corn from sweet kernels....58
Gold coin-flour corn.......	63	39	51	78	Has not yet been grown a 2d year.
Black Mexican-white dent.	36	81	58.5	51	From flint ker. of flinty e...53 From flint ker. of sweet e...40 From sweet ker. of flint e...39 From sweet ker. of sweet e..38.25
Stowell's-8-rowed	57.5	41	49.25	47	From selected ears.........49 From self-fertilized ears....38 From cross-fertilized ears...43
Stowell's-triumph	57.5	46.5	52	52.5	From self-fertilized seed....31 From cross-fertilized ear....48.5 " " " " ....41 Seed from selected ears....54 Seed from self-fertilized e...39
Stowell's-mammoth	57.5	61.5	59.5	61	Self-fer. ear, plat 88........43 " " " 76........52 From cross-fer. ear, plat 86.55 " " " " 87.45.5 Seed from selected ears.....55
Stowell's-gold coin........	57.5	62.5	60	62.5	From self-fer. ear, plat 89...48 " " " " 90...54 " " " " 91...54 Seed from selected ears.....58 Seed from self-fer. ear......48
Gold coin-triumph........	62.5	46.5	54.5	58.5	From cross-fer. ear, plat 93.56 " " " " 92.50 Seed from selected ears.....49
Gold coin-8-rowed........	62.5	41	51.75	56	Seed from selected ears.....50
Gold coin-8-rowed........	62.5	41	51.75	58	Not grown a second year.

seed naturally fertilized. The table giving the weight of ten selected ears of corn from self-fertilized seed and of ten ears from crossed or from selected seed does not give a correct idea of the inferiority of the corn from the self-fertilized seed because it does not take into account either the greater proportion of abortive stalks or of small and poorly filled ears.

From the work so far done there seems to be no way of telling beforehand what varieties will when crossed produce corn of an increased size and what will not. Some of the varieties which may be supposed to be most nearly related as the sweet corns, have shown but little increase when grown from crossed seed, while two varieties of pop-corn, which would seem as nearly related, to each other as the varieties of sweet corn, gave a very decided increase in size when grown from crossed seed. The corn grown from the cross of black Mexican and white dent, two widely different varieties, showed a decrease of size, while corn grown from a cross of flour corn and gold coin, varieties apparently as widely different as any crossed, gave ears showing the greatest proportionate gain in size.

It would be desirable to have a more perfect knowledge of the development of the races and varieties of corn. Many of our varieties of sweet corn are the result of accidental or intentional crosses with varieties of dent corn. This is especially true of the evergreen types, such as Stowell's, old Colony, gold coin, and others, some of them giving evidence of having been crossed two or more times. There are indications that one of the varieties of pop-corn, Queen's golden, is the result of a cross between another variety of pop-corn and a yellow dent variety. A more accurate knowledge of the parentage of varieties already possessed would be of value in the attempt at further improvement, as well as of scientific interest. The work of crossing and growing crossed seed has given some clews though not enough yet for publication.

In the production of new varieties by crossing it will seldom be desirable to cross two varieties that are very widely different from each other. It is probable that, on the whole, selection with occasional partial changes of seed will give more permanent as well as more satisfactory results for the general farmer than would the continual crossing and breaking up of well fixed types; though there does seem reason to believe that the crossing of such distinct and well fixed types will, for the time being at least, give larger corn and better yields.

It has long been a favorite theory among farmers that an occasional change of seed is advantageous. So far as is known no reason for the supposed benefit has ever been given. If the change seemed to prove advantageous all the good was attributed to the change of seed, as though change alone were a sufficient explanation. Where a grower continues to save his own seed year after year from the same lot of corn, there is what may be termed a sort of inbreeding, more or less close according as the acreage grown is large or small. If the same principle is applicable to corn as to our domestic animals, we should expect this inbreeding to tell sooner or later on the health, vigor, and size of the progeny. Among plants in a state of nature, where there must be much in the way of line breeding and some inbreeding, there is often brought into a community seeds only very distantly related, as where the blue jay carries acorns from one part of a forest to another sometimes many miles distant. When an acorn thus carried grows into a fruiting tree it brings in an element more or less distinct, just as the breeder of animals does when he goes to a herd more or less distantly related to his own to obtain stock for breeding. If advantage to the farmer comes as a result of making a complete change of seed, it must be because the seed grower is a more successful producer from some cause or causes than the seed buyer. But where the advantage comes through only a partial change it may be due to some other cause. It may be that the new introduction is superior, but has parted with some of its superiority so that the result is only an average of the two lots combined; or it may be that the introduction of the new strain or variety has not only added vigor to that before grown, but has itself taken on new vigor as a result of being grown with something of a strain or variety more distantly related.

There can be no doubt but that our cereals are as amenable to the breeder's art as are any other plants, or as animals. It is only a question of taking hold intelligently and working faithfully. If the man with false ideas as to plant breeding can succeed in making improvements, the man with correct notions should be so much the more successful.

This work gives us a clew to the relative prospects of improvment in other lines by cross breeding. A variety or type that is strongly fixed is more apt to transmit characters than one poorly or not at all fixed. If we should try to improve corn by crossing the product of two of these cross-bred groups of corn we should expect to get as a result a few superior ears with a very large proportion of inferior ones. Even in our well selected varieties that have been picked for years with reference to given points of excellence, the tendency to run back to inferior forms is so strong that the grower would save hardly one-tenth of his crop for his own seed. If our well selected varieties deteriorate thus when constantly and carefully selected, two varieties that have been long selected for opposite or widely different qualities must when crossed tend to neutralize most strongly the very traits which we have with so much pains brought out and maintained. If, on the other hand, the varieties crossed have long been selected on the same or very similar lines, there seems to be no reason why occasional crossing will not tend to fix more strongly the desired characters.

This idea carried over to the fruits (perennials) brings up the question whether or not there is after all much to be gained by crossing.

Outside of the wild species, there is nothing among them that would answer to the well selected varieties of corn, to form a basis from which to make a start. Apple trees from seed are propagated as varieties only when they differ from every other known variety. If a seedling of Ben Davis did not differ in some very noticeable character from its parent, there would be no thought of its perpetuation. Thus there are no varieties of apple in the sense that there are varieties of corn; and because we do not have a permanent type fixed by sexual generation, we cannot expect anything like the uniformity in growing natural seedlings, or seedlings from crosses of similar varieties of apple, that we should obtain by growing corn when bred pure or when pure and similar varieties are crossed.

METHODS OF CROSSING.

In doing this sort of work, or any other, for that matter, experimentally, it is essential that it be done in such a way that we are sure of our results. It will not do to find a few kernels in an ear differing from the rest and guess that they were crossed by some other variety growing near or that they had reverted to a former type. Such work leads only to a tangled maze. But having followed accurate methods and found that some good may be expected to come as a result of similar work on a larger scale, the methods of precision, may in a measure be laid aside, and something more practical used.

For our experimental work we have found the best method to be to cover up, before the silks are out, both the tassel and the coming ear, with a closely woven cloth bag. Covering the tassel of the stalk desired for a male parent insures a full supply of pollen, which seems to retain its vitality for several days if kept dry. Covering the shoot or prospective ear keeps away pollen not wanted. When the silks reach a length of three or four inches, the ear is ready for fertilization. We then gather the pollen on a sheet of smooth paper and roll it up funnel shaped. Next raise an umbrella and hold it in such a way as to keep all flying pollen from the ear, remove the bag, and apply the pollen until the silks are almost hidden. In favorable corn weather a single application of pollen is sufficient. Everything is to be kept carefully labeled.

For the farmer who wishes to undertake something of this kind on a larger scale, the best way would be be to plant a field, except one or more rows in the middle, with the variety proposed to be used as a male parent, and to plant in these rows that were left the other variety. As soon as the tassels come out cut them off from the female variety; and it would be well at the same time to cut them off from all the inferior stalks of the male variety.

The following are some of the most obvious conclusions drawn from the work of crossing corn:

The ear of corn may be as readily fertilized by pollen from its own stalk as by the pollen of another stalk. A stalk grown by itself fails to make a perfect ear only because the wind carries the pollen away.

The classes of corn, as dent, sweet, pop, and flour, can be intercrossed with perfect freedom. Corn cannot be a improved by self-fertilization.

There seems to be a strong tendency in the progeny of the crosses of the different classes of corn, dent, sweet, and pop, toward corn of the flint type.

The results from planting different ears of the same cross are apt to be quite different, and what appears to be the best ear does not always give the best results. The three ears produced by crossing mammoth with Leaming were all fertilized by the same pollen. The three ears planted separately produced lots of corn differing from each other fully as much as many of our well marked varieties. One of the three ears produced by crossing was decidedly superior in size and appearance to the other two, yet one of the inferior ears produced the largest and best corn.

G. W. McCluer, B. S., *Assistant Horticulturist.*

SWEET CORN, THICKNESS OF PLANTING, 1891.

Experiment No. 136.

May 12, 1891, 15 plats of sweet corn of three varieties were planted to note something of the effect of thickness of planting on the yield. All the plats were of 9 rows, each 2 rods long, 1-40 of an acre. The varieties used were Cory, Landreth's early or Burlington, and Roslyn hybrid.

Cory is the earliest and smallest variety commonly cultivated, usually growing about four feet high.

Burlington is nearly as early as the Cory but of larger growth, making stalks usually 5 to 6 ft. high, and much more leafy than the Cory.

Roslyn hybrid is one of the largest growing varieties of sweet corn, very similar in general character to the Stowell's, growing usually 7 to 8 ft. high, large and leafy.

Plats 1 to 5, Cory; 6 to 10, Landreth's early; and 11 to 15, Roslyn hybrid. The corn was all planted in hills. On all the plats the rows were 3 ft. 8 in. apart. In plats 1 and 6 the hills were put 12 inches apart; in plats 2, 7, and 11 the hills were planted 18 inches apart; in plats 3, 8, and 12 the hills were planted 24 inches apart; in plats 4, 9, and 13 the hills were planted 30 inches apart; in plats 5, 10, and 14 the hills were planted 36 inches apart; and in plat 15 the hills were 42 inches apart. The corn was thinned June 1st to 4 stalks per hill.

Plats 4, 5, 7, and 8 were very badly affected by the bacterial corn disease, described in bulletin No. 6, August, 1889. The other plats, as was most of the corn in this vicinity, were also affected but not to such an extent as those noted. Very early varieties of corn seemed more affected than the later ones that were planted at the same time. Some of the early corn grown by market gardeners was entirely destroyed. The corn first assumes a yellowish appearance, stops growing, and then, in bad cases, rots off at the ground.

The corn was given the ordinary field cultivation.

Owing to the diseased condition of the plats all the ears and nubbins in each plat were counted together as ears, and all were then weighed, and no further account taken of them.

The following table gives results:

YIELD OF SWEET CORN PLANTED AT DIFFERENT DEGREES OF THICKNESS, 1891.

Plat.	Variety.	Distance of hills apart, inches.	Number of ears.	Weight of corn, lb.
1	Cory....................	12	481	30
2	"	18	382	22
3	"	24	377	27½
4	"	30	264	18½
5	"	36	219	13
6	Burlington................	12	671	72
7	"	18	571	53½
8	"	24	473	61½
9	"	30	419	64
10	"	36	379	68
11	Roslyn hybrid.............	18	295	60
12	"	24	276	65
13	"	30	260	68
14	"	36	268	69
15	"	42	288	98

G. W. McCLUER, *Assistant Horticulturist.*

THE LATE SEASON AND THE CORN CROP.

The situation as regards the corn crop for 1892 is serious in Illinois as well as in other corn growing states. Not for many years has there been so small an acreage planted in Illinois at corresponding date, May 12th, as now. Much land remains unplowed. The temperature is low, the soil cold. Many thousands of acres of low lying land are either covered with water or thoroughly saturated. But with favorable weather in future there is no reason for panic or fear of a failure of the crop. Trials at this Station for four years past show that good crops may be expected, in seasons of ordinary character, from planting any time in May. The best yields have come from planting between May 11th and 16th. If the planting can be completed in Central Illinois by May 25th, or even May 30th, the land being in good condition and late maturing varieties avoided, there need be little anxiety so far as date of planting is concerned. Fair crops of corn may be secured by planting early maturing varieties as late as June 10th, should that be necessary, if the season afterward be favorable. Late planted corn will mature in a less number of days than corn of the same variety planted earlier.

It is believed to be better to wait until the ground is fairly dry rather than either to plow or plant while it is very wet. Time and labor spent in getting the ground in good condition and free from weeds will probably be well repaid, even at the cost of two or three days longer delay in planting.

Where overflowed lands do not become dry until too late for the corn crop and then do get in good working condition, it is probable so large a crop of good stock food can be procured in no other way so quickly and cheaply as by sowing the land to millet, which can be harvested in time to permit the sowing of a wheat crop in September.

G. E. MORROW, M.A., *Agriculturist.*

All communications intended for the Station should be addressed, not to any person, but to the

AGRICULTURAL EXPERIMENT STATION, CHAMPAIGN, ILLINOIS.

The bulletins of the Experiment Station will be sent free of all charges to persons engaged in farming who may request that they be sent.

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UNIVERSITY OF ILLINOIS,

Agricultural Experiment Station.

CHAMPAIGN, AUGUST, 1892.

BULLETIN NO. 22.

EXPERIMENTS WITH WHEAT, 1891–92.

Some of the results of experiments tried with wheat in the season 1891–92 are here given, with reference also to like experiments of previous years.

These experiments are reported:

No. 53. Effect of time and manner of harvesting on yield of wheat.
No. 65. Quantity of seed.
No. 66. Time of sowing.
No. 67. Depth of sowing.
No. 62 and 69. Effect of fertilizers.
No. 116. Test of varieties.

SUMMARY.

The following is a summary of some experiments with wheat made at the Agricultural Experiment Station of the University of Illinois, Champaign, on fertile, dark colored prairie soil, for the season of 1891–92; and of experiments made at Flora, Odin, Belleville, and DuQuoin, to test the effect of manures on wheat.

The year 1891 was one of unusual drouth, continuing until November. The winter was rather mild, with a fair rain-fall. The spring of 1892 was characterized by unusually heavy rains.

Temperature and Rainfall, July, 1891, to June, 1892.

	1891 and 1892.		Average for 10 years.	
	Rainfall.	Temperature.	Rainfall.	Temperature.
July, 1891	1.41	70.1	2.73	77.5
August	2.86	74	3.45	74.6
September	.41	69.2	3.27	66.5
October	1.29	51.3	3.27	54.6
November	5.58	35.7	2.76	40.6
December	1.53	37	2.47	27.1
January, 1892	.79	19.2	1.54	22.8
February	2.64	33	3.42	29.7
March	2.59	36.1	2.61	39
April	6.45	48.6	3.19	52.4
May	7.86	57.9	4.45	64.6
June	5.36	70.6	5.04	71
Total	38.77	....	38.20	....

The experiments at the Station were made on soil which had grown a crop of oats in 1891. The land was plowed in August, was disked twice, harrowed, and rolled before seeding. The wheat made but feeble growth in the autumn. The growth of straw in the spring was heavy. Much of the wheat lodged badly.

Variety Tests. Sixty varieties were sown on one-tenth acre plats, and 12 of Carter's cross-bred wheats in smaller plats. None of these last were worth harvesting. Several other varieties, generally of foreign origin, failed.

Fifty-six plats, representing 48 varieties as named, gave an average yield of 29 bu. per acre. The largest yield was at the rate of 35.4 bu; the smallest, 16.3 bu.; the next smallest, 22 bu. Twenty-two plats yielded at the rate of over 30 bu.; six, less than 25 bu. each. All of the wheat was light in weight; 58 lb. a bushel being the highest, 51.25 lb. the lightest weight; the wheat from 18 plats weighing less than 55 lb. a bu.

Twenty-five plats of bearded wheat gave an average yield of 30.8 bu.; 28 plats of bald wheat an average of 27.5 bu. an acre. Six varieties were classed as white wheat. These gave an average yield of 25.8 bu. an acre, the largest yield being 30.3 bu.

Of the red bearded varieties the following gave yields of 30 bu. or more an acre, averaging over 33 bu.: Hindustan, Diehl Mediterranean, Deitz, Tuscan Island, Lehigh, Crate, Tasmanian red, velvet chaff, nigger, golden cross, new longberry Wabash, and Lebanon.

Of red bald varieties Poole, Currell's prolific, longberry, and improved rice gave yields of 30 to 32 bu. an acre.

Of white bald varieties golden prolific gave 30 bu., and of the white bearded Democrat gave the same yield.

These plats were drilled at the rate of six pecks an acre, from Sept. 25th to Sept. 29th.

Thickness of Seeding. Seeding at the rate of 4 pecks an acre gave yields of 24.7 bu. an acre; 5 pecks, 29 bu.; six, 28 bu.; eight, 27.8 bu. In a series of years seeding at the rate of from 5 to 6 pecks an acre has given the best results.

Time of Sowing. Wheat sown Sept. 2d gave a yield of 29 bu.; Sept. 11th, 28.5 bu.; Sept. 20th, 28.7 bu.; Oct. 5th, 27.2 bu.; Oct. 13th, 21.7 bu. The yield of straw steadily decreased from earliest to latest sowing. In trials for several years no material difference has been found in the yields of wheat sown any time in September.

Depth of Seeding. Little difference in yield was found when the wheat was covered one inch or three inches. That covered five inches yielded considerably less.

Effect of Fertilizers. Application of stable manures, bone meal, and blood and bone fertilizers gave litttle or no increase in yield of wheat on the Station grounds. In trials in southern Illinois stable manures produced a marked effect and the other fertilizers sufficient yields to make further trials advisable.

Effect of Time of Harvesting. Harvesting at different stages of ripeness showed a constant increase in both yield and size of berry from earliest up to latest. At the latest date the wheat was "dead" ripe.

Experiment No. 65. Wheat, Quantity of Seed.

For four successive years an experiment has been tried to test the effect of sowing different quantities of seed per acre. In 1891 six plats were drilled Oct. 6th as nearly as practicable at the rates indicated in the table, which also gives the results. These show that the largest yield of both grain and straw came from seeding at the rate of five pecks per acre.

The average results from duplicate plats for each of the four years are given in a second table. In no year has there been any remarkable variation in yield caused by difference in rate of seeding, unless 1891 be an exception. In that year there was an extreme difference of over seven bushels per acre.

For two years the stubs after cutting have been counted on several square feet on each plat. Considerable variation has been shown, but the numbers have not in all cases varied with the rate of seeding.

YIELD OF WHEAT FROM DIFFERENT AMOUNTS OF SEED, 1891-2.

Plat No.	Rate of seeding.	Wt. 100 kernels, grams.	Stubs per sq. ft.	Lb. per bu.	Yield per acre.	
					Straw, lb.	Grain, bu.
62	6 pecks per acre........	2.4	54	53	2,950	25.8
63	6 pecks per acre........	2.76	61	54	3,140	26
64	5 pecks per acre........	2.82	54	55.25	3,357	29
65	4 pecks per acre........	2.8	41	55	2,575	24.7
66	8 pecks per acre........	2.86	....	55	2,670	27.8
46	6 pecks per acre (small seed)	2.58	46	55.25	3,230	26.8

YIELD OF WHEAT FROM DIFFERENT AMOUNTS OF SEED, 1888-9 TO 1891-2—DUPLICATE PLATS.

Seed per acre, pecks.	Yield per acre.									
	1888-9.		1889-90.		1889-91.		1891-92.		Average.	
	Straw, lb	Grain, bu.	Straw, lb.	Grain, bu.	Straw, lb.	Grain, bu.	Straw, lb.	Grain, bu.	Straw, lb.	Grain, bu.
3	......	......	2,215	24.6	4,140	22	......	.....	3,177	23.3
4	4,560	36.2	2,620	28.2	4,400	23.7	2,575	24.7	3,539	28.2
5	4,700	38.3	2,740	26.3	4,080	22.2	3,357	29	3,719	28.9
6	4,750	36.3	2,200	24.5	4,980	28.3	3,045	25.9	3,822	28.8
8	4,540	35.4	2,740	28.3	5,100	26.8	2,670	27.8	3,762	29.6

Experiment No. 66. Wheat, Time of Sowing.

Trials of the influence on yield of grain and straw of sowing wheat at different dates have been made for four years. In the trials for 1891–92, the land used had produced a large crop of oats in 1891. It was plowed during August. Each plat was disked twice, harrowed, and rolled just before the wheat was drilled in. While all the plats made but feeble growth during the autumn because of the drouth, the earlier sown made the best growth and appeared most vigorous in the spring.

YIELD OF WHEAT FROM SOWINGS AT DIFFERENT DATES, 1891-92.

Plat No.	Date of sowing.	When harvested.	Stubs per sq. ft.	Wt. 1000 kernels, grams.	Lb. per bu.	Yield per acre.	
						Straw, lb.	Grain, bu.
76	Sept. 2........	July 7.....	51	27.6	56	3,495	29.1
77	Sept. 11.......	July 7.....	55	26.6	55	3,238	28.4
78	Sept. 21.......	July 13.....	57	27.6	55	2,861	26.7
79	Oct. 5.........	July 13.....	50	27	55	2,658	27.2
80	Oct. 13......	July 13.....	47	....	55.5	2,003	21.7

YIELD OF WHEAT FROM SOWINGS AT DIFFERENT DATES, 1889 TO 1892.

Date of Sowing.	1889.			1890.			1891.	1892.			Average		
	Straw, lb.	Grain, bu.	Wt. 1000 kernels, gr.	Straw, lb.	Grain, bu.	Wt. 1000 kernels, gr.	Grain, bu.	Straw, lb.	Grain, bu.	Wt. 1000 kernels, gr.	Straw, lb.	Grain, bu.	Wt. 1000 kernels, gr.
Sept. 2............	....	....	....	....	....	....	30.9	3495	29.1	27.6	....	30	....
Sept. 11-12........	....	....	....	3750	32.4	34.3	36.1	3238	28.4	26.6	3494	32.3	30.4
Sept. 21-23........	4570	38.2	36.4	3170	29.1	34.5	34.5	2861	26.7	27.6	2650	32.1	32.8
Sept. 29-Oct. 5....	4505	40.4	34.8	2450	20.8	33.6	36.4	2658	27.2	27	3204	31.2	31.8
Oct. 8-15..........	3905	36.1	33.9	1710	12.1	30	34.1	2003	21.7	....	2539	26	31.9

The table gives the dates of seeding and the yield of each plat, both of straw and of grain, the weight of 1,000 kernels from each plat, and like facts from the trials in previous years. In no year was there any remarkable difference in yield of grain between the plats sown any time in September. (The yield of the earliest sown plat in 1891 was somewhat decreased by the effect of shade of trees near by.)

The yield of straw has generally decreased from the first to the last sowing.

Experiment No. 67. Wheat, Depth of Sowing.

To compare the growth and yield of wheat sown at different depths nine rows 12 in. apart, each one rod long, were planted Oct. 8, 1891, each row with 198 kernels of selected seed wheat, or one kernel to each inch in the rows. The seed in rows 1, 2, and 3 was covered one inch deep; in rows 4, 5, and 6, three inches; in 7, 8, and 9, five inches. An extra row was planted on each side of the plat. The wheat made but feeble growth in the autumn and April 1st was in poor condition. It was cut July 14th, when it was all ripe and all standing.

The table gives details of the results.

There were considerable variations in the rows covered to the same depth. In no case did much more than one-third of the kernels produce plants which came to maturity. The average number of straws in each stool was low, five being the highest in any one row. While the yields of adjoining rows varied more than the yields from planting at different depths, slightly the best results came from the three rows covered one inch deep. A like result was found in the year previous.

The unsatisfactory results usually obtained from experiments in which only small numbers of plants or animals are used is well illustrated in this table.

YIELD OF WHEAT FROM SOWINGS AT DIFFERENT DEPTHS, 1891-92.

Row No.	Depth planted.	No. stools.	No. smut heads.	No. straws.	Wt. straw, grams.	Wt. grain, grams.	Wt. 1000 kernels, grams.
1	One in.	58	10	304	501.8	205.4	27
2	"	72	23	324	554.8	242.4	28
3	"	70	29	350	613.8	267.8	28
4	Three in.	71	20	348	604.5	268	27
5	"	58	21	243	423.9	185.5	27.8
6	"	47	16	303	583.4	241.6	27.1
7	Five in.	44	18	181	333.1	133.4	26.3
8	"	56	19	260	491.2	202.8	28.2
9	"	39	7	168	343.5	141.6	27.2

Experiment No. 62. Wheat, Effect of Fertilizers. [At Station.]

The effect of different kinds of manures on wheat has been tried on the Station grounds for four years.

For the season of 1891 eight plats were used, each one-fourth of an acre in extent. On each of two plats 100 lb. bone meal was applied; on each of two others 100 lb. bone and blood. These manures were sown broadcast by hand Oct. 7th, immediately before the wheat was sown. In January, 1892, five loads of rather coarse and strawy manure mostly from the horse stables, was applied to one plat. On three plats no manure was applied. No appreciable difference in the condition of the wheat on the different plats was observed either in the autumn or early spring. The table gives the results.

While there are considerable differences in the yields of the plats, these are believed to be owing more to the differences in soil than to the effect of manures applied. The plats were each 2x20 rods. Plats 68 and 72, 69 and 73, 70 and 74, and 71 and 75 were side by side. Except in plats 70 and 74 there was in no case a difference of one bushel per acre in the yield of the plats of any pair of plats. In this case the plat to which nothing had been applied yielded at the rate of 3.2 bu. per acre more than the adjoining plat on which manure had been applied. The wheat on the plat to which barn yard manure was applied lodged much more than that on the adjoining plat.

The application to wheat of no form of the commercial fertilizers yet tested at the Station has proved profitable.

Samples of the two commercial fertilizers used, as analyzed by E. H. Farrington, Chemist of the Station, had the following composition:

	Bone meal.	Bone and blood.
Nitrogen	3.42	5.67
Total phosphoric acid	26.23	15.48
Available	10.03	7.14
Insoluble	16.25	8.34

YIELD OF WHEAT FROM FERTILIZED PLATS, 1891-92.

Plat No.	Fertilizer.	Per cent standing at harvest.	No. of stubs, per 1 sq. ft.	Grain per acre, bu.
68	100 lb. bone meal	67	50	25.3
72	5 loads barnyard manure	25	46	25
69	Nothing	75	54	26.7
73	100 lb. bone meal	50	56	27.2
70	100 lb. bone and blood	0	54	26.1
74	Nothing	5	56	29.3
71	Nothing	100	38	23
75	100 lb. bone and blood	100	45	22.8

Experiment No. 69. Wheat, Effect of Fertilizers. [Southern Illinois.]

For four years past trials of different commercial fertilizers for wheat have been made at different places in the southern part of the state, Flora, Odin, Nashville, Belleville, and DuQuoin. With the exception of the land near Belleville, all the trials have been on the level, light colored soils, with very compact sub-soils, characteristic of central southern Illinois.

For 1891 and 1892 the experiments were tried on the farms of W. W. Bowler, Flora; A. M. Woodward, Odin; H. Horn, DuQuoin; and Fred Helms, Belleville. Mr. Helms' farm is naturally very fertile.

In each case eight one-fourth acre plats were laid off side by side in fields to be sown with wheat. The plats were long and narrow.

The fertilizers were applied as follows:

To plat No. 1, 5 loads stable manure.
" " " 2, nothing.
" " " 3, 100 lb. bone meal.
" " " 4, 100 lb. blood and bone.
" " " 5, nothing.
" " " 6, 100 lb. bone meal.
" " " 7, 100 lb. blood and bone.
" " " 8, nothing.

The bone meal and blood and bone were the same as used in Experiment No. 62.

In general the soil of the different tracts seemed uniform. Aside from the fertilizing, the treatment of all the plats was the same throughout.

The table gives the results, which are not uniform at the different places, nor in accordance with the experience in previous years. As in former years, the plats with barnyard manure gave the best results, except at Flora. At Odin the yield from the plat to which stable manure was applied was at the rate of 14 bu. in excess of the plats to which the commercial fertilizers were applied, and nearly 17 bu. more than the average of the plats to which nothing was applied. In all four cases the stable manure produced a marked increase of yield over that from the unmanured plats, the average yield from the four plats treated with stable manure being at the rate of 28.5 bu. per acre, while that from the 12 plats having no manure was at the rate of 18.8 bu. per acre. The average yield of the 16 plats to which commercial fertilizers had been applied was at the rate of 24 bu. per acre; the yield of the eight plats receiving blood and bone averaged 25.1 bu. per acre; that of the eight plats receiving bone meal averaged 22.8 bu. per acre.

A considerable variation is shown in the yield of the different plats treated with the same fertilizers, as well as in the plats without any fertilizer.

At Odin the two plats to which bone meal was applied gave a less yield than the three to which nothing had been applied, while each of the two plats to which bone and blood had been applied gave a much larger yield than either one of those to which nothing had been applied.

As a whole these results are more favorable to the use of these commercial fertilizers than those in any other years. As in each of the former years, these results emphasize the great value of stable manure.

YIELD PER ACRE, BU., FROM FERTILIZED AND UNFERTILIZED PLATS, 1891-2.

No. of plat.	1	3	6	4	7	Average.	2	5	8	Average.
Fertilizer.	Barnyard manure.	Bone meal.		Blood and bone.			Nothing.			
Flora..............	19.3	20.5	15.3	22.3	19	19.3	16 6	13.3	12.9	14.3
Odin..............	31.7	15.1	13.3	23.3	19	17.7	15.9	15.7	12.7	14 8
DuQuoin.........	24.5	24	21	24	22	22.7	16.	17	14	15.7
Belleville.........	38.5	35.9	37.8	35.2	36 3	36.3	28.7	32.1	30.2	30.3
Average.......	28.5	22.8		25.1		24				18 8

Experiment No. 116. Wheat, Test of Varieties.

To compare the yield and other qualities of varieties, 62 plats of one-tenth of an acre each were sown from Sept. 25 to Sept. 29, 1891, with what were named as varieties, with duplicates, and with four mixtures, each of several varieties possessing similar qualities. These plats were in the same field as that in which all the other experiments with wheat at the Station were tried, and the preparation of the soil was the same as reported in those experiments. The rate of seeding in each case was six pecks per acre, as nearly as practicable.

Most of the varieties were obtained from the Ohio Agricultural Experiment Station, at Columbus. A few came from the Pennsylvania Agricultural Experiment Station, at State College, and a few from different individuals. In a number of cases samples of wheat received under different names very closely resemble each other, not only in kernel but in stalk, head, time of ripening, and yield.

In addition to these varieties twelve cross bred varieties, originated by Carter, of London, England, the seed of which had been received in 1890 and sown that autumn, were sown in smaller plats. The seed as received from England was very attractive, the kernels being large, plump, and of good color. The product at the first harvest was unsatisfactory, all the varieties maturing too late to make them desirable, and the kernels being much shriveled. All the varieties failed almost entirely in the second season's trial. No one of the plats was worth harvesting and in several of them scarcely any heads were produced.

The tables give the results of these trials. The date of ripening, yields both of straw and grain, and the weight per bushel of nearly all the varieties tested here are given from the reports of the trials of the same varieties for the same season at the Ohio Station, at Columbus, and for ten varieties from the report of the tests at the Indiana Station, at LaFayette. It is noticeable that without exception the time of ripening of any given variety was several days later at this Station than at either of the others, in several cases the difference being from ten to thirteen days. The wheat harvest in this vicinity was unusually late in 1892. In the case of a number of varieties the yields at the different stations are quite uniform; in others, there are striking differences.

At this Station the average yield of the plats was good, 56 plats giving an average yield of 29 bu. per acre. The largest yield was 35.4 bu. per acre. With one exception, no plat gave less than 22 bu. per acre. Twenty-two plats gave yields of over 30 bu. per acre each, only 6 less than 25 bu. each. The wheat was all of inferior quality as judged by appearance as well as weight, that from no plat exceeding 58 lb. per bu. The weight of these varieties, as grown at the Ohio and Indiana stations, averaged somewhat higher, but was less than the weights in other years.

Twenty-five plats of bearded wheat gave an average yield of 30.8 bu. an acre; 28 plats of bald wheat, an average of 27.5 bu.

Six varieties were classed as white wheat. These gave an average yield of 25.8 bu. an acre, the largest yield being 30.3 bu.

Of the white bald varieties, golden prolific gave 30 bu. and of the white bearded, Democrat gave the same yield.

Of the red bearded varieties, the following gave yields of 30 bu. or more an acre, averaging over 33 bu.: Hindustan, 35.4; Diehl Mediterranean, 35.1; Deitz, 34.5; Tuscan Island, 34.1; Lehigh, 34.4; Crate, 33.7; Tasmania, red, 33.4; velvet chaff, 33.4; Nigger, 31.6; golden cross, 32.2; new longberry Wabash, 30.7, and Lebanon, 30.6. Of the red bald varieties, Poole, Currell's prolific, longberry, and improved rice gave yields of 30 to 32 bu. an acre.

Four mixtures designated in the table (p. 118) as *a*, *b*, *c*, and *d*, were made of varieties which, in appearance and in description of other characteristics, seemed much alike. These mixtures were composed of equal parts of the following varieties:

Mixture *a*, velvet chaff [Penquite's] Lehigh, Hindustan, Tasmanian red, Nigger, Diehl Mediterranean, TuscanIsland, Miami Valley, long berry Wabash, bearded monarch, and Fairfield.

Mixture *b*, Wyandot red, Poole, Witter, Sheriff, Hicks, Fultz, Currell's prolific, Oregon, long berry, and early ripe.

Mixture *c*, Russian red, improved rice, extra early Oakley, and Crate.

Mixture *d*, Deitz, Lebanon, and Theiss.

In each case the yield of grain per acre from the mixture was greater than the average yield from the varieties composing it, and in all but one the pounds of straw and pounds per bushel were greater. The increased yields from the mixtures over the average yields from their components was 2.5, 2, 2.4, and 2.8 bushels per acre for mixtures *a*, *b*, *c*, and *d*, respectively.

The results of tests of varieties for one year can not be considered at all conclusive. In view of the reasonably close agreement in behavior of varieties treated this year at this Station and at the Ohio Station (p. 116), where a number of the varieties have been grown for several years, the recommendations contained in the report of the Ohio Station for 1892 is given:

> "Judging from the experience of this and former years, we recommend the following sorts of wheat as probably the safest for general culture throughout Ohio: Valley, Fultz, velvet chaff [Penquite's] Egyptian, and Nigger. Diehl Mediterranean, under its various names, has given good yields on this farm and in favored localities, but cannot be recommended for general culture, and the same may be said of Martin's amber and its synonyms Landreth and silver chaff. Rudy, Deitz, Poole, Currell's prolific, early red Clawson, Hicks, and Jones's winter fife, are worthy of further trial."

WHEAT—VARIETY TESTS, 1891-92.

Plat No.	Name of variety.	Source of seed.	Ripe, July	Cut, July	Ht., in.	Bearded or bald	Color of kernels.	Wt. 100 kernels, grams.	No. stubs on 1 sq. ft.	Lb. per bu	Yield per acre		Per cent standing at harvest.
											Straw, lb.	Grain, bu.	
1	Currell's prolific	Ohio Experiment Station	9	9	52	Bald	Red	2.52	52	55.75	2,991	31	50
2	Sheriff	''	12	12	49	''	''	2.6	34	52.75	2,871	22.2	100
3	Hicks	''	12	12	48	''	''	2.74	47	56.75	3,179	28.6	100
4	Fultz	''	9	12	50	''	''	2.44	55	55	3,687	28.6	75
5	Witter	''	12	12	57	''	''	2.22	48	52.25	3,453	27.2	50
6	Miller's prolific	''	15	14	47	75% bald	White	2.24	42	51.25	1,942	16.3	100
7	Wisconsin triumph	''	9	11	48	Bald	Red	2.3	44	55.5	2,237	25.5	100
8	Early ripe	''	11	11	51	''	''	2.74	46	55.75	2,923	28	90
9	Wyandot red	University farm	9	11	48	50% bald	''	2.7	48	55	2,921	30.2	100
10	Ohio early ripe	''	11	9	54	Bald	''	2.74	77	53.25	3,769	28.4	67
11	New longberry Wabash	Ohio Experiment Station	12	12	54	Bearded	''	3.18	60	54.25	3,307	30.7	0
12	Fairfield	''	13	12	50	''	White	2.4	47	52.5	3,568	24.2	90
13	Miami Valley	''	12	12	55	''	Red	2.7	54	54.75	4,368	28.8	25
14	Velvet-chaff [Penquite's]	''	6	9	53	''	''	2.54	49	56.25	3,910	33.4	100
15	Nigger	''	11	11	50	''	''	3.24	44	54.5	3,212	31.7	40
16	Finley	Pennsylvania Experiment Station	9	11	54	Bald	''	2.5	38	56	2,249	26.1	100
17	Ohio early ripe	University farm	9	11	54	''	''	2.88	45	54.5	2,932	27.3	90
18	Longberry	Ohio Experiment Station	9	11	54	''	''	2.56	52	54.5	2,889	30.2	90
19	New monarch wheat		11	11	57	Bearded	''	2.56	42	55	3,750	22	100
20	German emperor	Pennsylvania Experiment Station	11	9	56	75% bald	''	2.62	41	55	3,433	28.1	50
21	Mealy	Ohio Experiment Station	9	9	53	Bald	''	1.74	45	51.5	3,355	25.6	100
22	Crate	''	9	9	59	Bearded	''	2.84	58	55.25	4,128	33.7	33
23	Improved rice	''	9	9	60	Bald	''	2.52	49	55.25	2,759	30.4	33
24	Extra early Oakley	''	9	11	46	''	''	2.42	55	56.25	3,411	29.3	33
25	German emperor	''	11	11	54	''	''	2.86	45	54.5	2,811	24.3	95
26	Oregon	''	11	11	51	''	''	2.38	52	55.5	3,562	28.7	90
27	Big English	''	19	11	53	Bearded	''	2.26	48	56.25	3,095	26.9	100
28	Bearded monarch	''	12	12	58	''	''	2.5	49	53.5	3,411	29.3	80
29	McGhee's white	Pennsylvania Experiment Station	9	9	55	Bald	White	3.74	50	54.5	2,999	27.1	100
30	Hybrid Mediterranean	''	11	11	54	Bearded	Red	3.04	51	55.75	2,313	24.1	100
33	Red Russian	Ohio Experiment Station	9	11	50	Bald	''	2.76	47	55.75	2,924	28.7	100

34	Poole	"	9	11	50	"	"	2.78	55	56.5	3,007	32.2	100
35	Ontario wonder	'	14	14	54	"	"	2.64	49	56.25	3,452	25	100
36	Martin's amber	"	14	14	49	"	White	2.86	38	55	3,274	27.3	100
37	Lehigh	"	12	12	57	Bearded	Red	3.38	51	55.75	3,873	34.4	0
38	Golden cross		9	9	56	"	"	3.14	48	56	3,575	32.2	100
39	Theiss		9	12	56	"	"	2.26	57	55.25	3,612	26.4	0
40	Deitz longberry red	Pennsylvania Experiment Station	12	12	58	"	"	3	45	55.75	3,343	30	0
41	Democrat	Ohio Experiment Station	12	12	56	"	White	2.58	51	55.25	3,767	30.3	33
42	Golden prolific	"	13	12	50	Bald	"	2.84	52	52	3,717	29.7	100
43	Tasmanian red	"	12	12	57	Bearded	Red	2.9	52	56.75	3,835	33.4	0
44	Lebanon	"	12	12	58	"	"	3.34	45	57.25	3,451	30.6	50
45	Tuscan Island	"	12	12	57	"	"	3.64	55	57.5	3,277	34.1	50
46	Ohio early ripe [small seed]	University farm	13	11	50	Bald	"	2.58	46	55.25	3,230	26.8	50
47	Mixture *a*		11	11	55	Bearded	"	3.28	48	58	3,404	33.4	95
48	Mixture *b*		11	11	54	Bald	"	2.38	57	55.25	3,730	30.7	100
49	Mixture *c*		13	11	51	Bearded	"	2.6	51	55.25	3,641	32.9	25
50	Mixture *d*		11	11	58	"	"	2.86	53	56.5	3,703	33.3	0
51	Fulcaster	Pennsylvania Experiment Station	9	11	55	"	"	2 86	46	57.25	2,778	27.7	50
52	Deitz	Ohio Experiment Station	11	11	60	"	"	3	45	55	3,948	34.4	10
53	Hindustan	"	11	11	57	"	"	3.24	56	55.25	4,085	35.4	25
54	Diehl Mediterranean	"	11	11	50	"	"	3.47	47	57.75	3,306	35.1	100
57a	Walker's winter	E. W. Bryant, Princeton, Ill	12	12	51	Bald	"	2.52	55	56.75	2,382	27.6	33
57b	Saskatchewan Fife	D. L. Wellman, Frazee City, Minn	...	...	...	"	"	......	37	......	2,895	8.7	......
62	Ohio early ripe	University farm	12	12	...	"	"	2.4	54	53	2,950	25.8	100
85	Poole	D. H. Shank, Paris, Ill	12	14	...	"	"	......	....	......	......	24	100
67	Rudy	H. J. Ritter, Tippecanoe, O	13	14	47	Bearded	"	3.78	49	......	2,499	28.6	100

WHEAT—VARIETY TESTS IN ILLINOIS, OHIO, AND INDIANA, 1891-92.

Name.	Illinois.				Ohio.				Indiana.			
	Ripe July 6-14.	Yield, acre.		Lb. per bu.	Ripe, June 30 to July 6.	Yield, acre.		Lb. per bu.	Ripe, June 28 to July 1.	Yield, acre.		Lb. per bu.
		Straw, lb.	Grain, bu.			Straw, lb.	Grain, bu.			Straw, lb.	Grain, bu.	
Currell's prolific	9	2,991	31	55.75	30	3,105	20.9	58.5	......	......	......	......
Sheriff	12	2,871	22.2	52.75	2	2,345	24.2	59	......	......	......	......
Hicks	12	3,179	28.6	56.75	1	2,230	22.7	......	......	......	......	......
Fultz	9	3,687	28.6	55	2	3,575	30.4	59	28	4,129	34.2	58.5
Witter	12	3,453	27.2	52.25	5	2,700	30	59	......	....	......	......
Miller's prolific	15	1,942	16.3	51.25	6	1,790	20.2	56	......	......	......	......
Wisconsin triumph	9	2,237	25.5	55.5	30	2,760	25.7	57	29	3,701	33.1	58
Early ripe	11	3,161	27.3	54.5	30	3,035	26.1	54	......	......	......	......
Wyandot red	9	2,921	30.2	55	4	2,775	28.7	57.5	28	3,762	35.8	58
New longberry Wabash	12	3,307	30.7	54.25	5	2,555	22.4	55	1	4,919	24.4	55.5
Fairfield	13	3,568	24.2	52.5	3	2,785	25.6	51.5	....	......	......	......
Maimi valley	12	4,368	28.8	54.75	2	2,885	25.2	59.5	......	......	......	......
Velvet chaff	6	3,910	33.4	56.25	......	......	25.4	......	......	......	......	......
Nigger	11	3,212	31.7	54.5	1	2,400	30	60	......	......	......	......
Longberry	9	2,889	30.2	54.5	2	2,490	25.2	57	29	4,051	32.1	59
New monarch	11	3,750	22	55	30	2,675	22.1	58	30	3,905	36.4	58
German emperor	11	3,122	26.2	54.75	4	2,635	27.7	56.5	......	......	......	......
Mealy	9	3,355	25.6	51.5	2	2,355	26.6	55.5	......	......	......	......
Crate	9	4,128	33.7	55.25	2	2,360	24	58	....	......	......	......
Improved rice	9	2,759	30.4	55.25	30	3,055	25.7	58.5	......	......	......	......
Extra early Oakley	9	3,411	29.3	56.25	2	2,960	27.3	59.5	......	......	......	......
Oregon	11	3,562	28.7	55.5	2	3,180	27	59.5	......	......	......	......
Big English	9	3,095	26.9	56.25	5	2,525	27.2	60	......	......	......	......
Bearded monarch	12	3,411	29.3	53.5	2	2,675	22.1	53	......	......	......	......
Red Russian	9	2,924	28.7	55.75	2	2,045	27.1	59	......	......	......	......
Poole	9	3,007	32.2	56.5	4	2,495	30.1	58.5	......	......	......	......

Ontario wonder	14	3,452	25	56.25	2	3,285	23.6	56	......	......	......	......
Martin's amber	14	3,274	27.3	55	2	2,790	25.2	57	......	......	......	......
Lehigh	12	3,873	34.4	55.75	4	3,280	27	57.5	......	......	......	......
Golden cross	9	3,575	32.2	56	4	2,620	31.3	59	1	4,289	30.4	58.5
Theiss	9	3,612	26.4	55.25	30	2,700	23.3	56	......	......	......	......
Democrat	12	3,767	30.3	55.25	4	3,400	29.5	58.5	......	......	......	......
Golden prolific	13	3,717	29.7	52	5	2,575	28.2	55	......	......	......	......
Tasmanian red	12	3,835	33.4	50.75	30	3,643	29.6	59.5	......	......	......	......
Lebanon	12	3,451	30.6	57.25	4	3,800	30	59.5	......	......	......	......
Tuscan Island	12	3,277	34.1	57.5	1	2,575	31.1	58.5	......	......	......	......
Fulcaster	9	2,778	27.7	57.25	2	3,825	27.1	57.5	30	3,798	24.5	57
Deitz	11	3,948	34.5	55	4	3,350	30.5	60	......	......	......	......
Hindustan	11	4,085	35.4	55.25	4	3,960	31.3	60	......	......	......	......
Diehl Mediterranean	11	3,306	35.1	57.75	4	2,520	29.7	58.5	......	......	......	......
Rudy	13	2,499	28.6	......	30	2,645	25.9	57.5	30	6,162	34.7	54.5
Deitz longberry	12	3,346	30	55.75	......	......	......	......	30	4,970	27.4	56.5

WHEAT—YIELDS OF MIXTURES, 1891-92.

	Wt. 100 kernels, grams.	Lb. per bu.	Yield per acre.	
			Straw, lb.	Grain, bu.
Components of mixture a.				
Velvet chaff [Penquite's]	2.54	56.25	3,910	33.4
Lehigh	3.38	55.75	3,873	34.4
Hindustan	3.24	55.25	4,085	35.4
Tasmanian red	2.9	56.75	3,835	33.4
Nigger	3.24	54.5	3,212	31.7
Diehl Mediterranean	3.47	57.75	3,306	35.1
Tuscan Island	3.64	57.5	3,277	34.1
Miami Valley	2.7	54.75	4,368	28.8
Longberry Wabash	3.18	54.25	3,307	30.7
Bearded monarch	2.5	53.5	3,411	29.3
Fairfield	2.4	52.5	3,568	24.2
Average of above	3.02	55.3	3,650	31.9
Yield from mixture of seed	3.28	58	3,404	33.4
Components of mixture b.				
Wyandot red	2.7	55	2,921	30.2
Poole	2.78	56.5	3,007	32.2
Witter	2.22	52.25	3,453	27.2
Sheriff	2.6	52.75	2,871	22.2
Hicks	2.74	56.75	3,179	28.6
Fultz	2.44	55	3,687	28.6
Currell's prolific	2.52	55.75	2,991	31
Oregon	2.38	55.5	3,562	28.7
Longberry	2.56	54.5	2,889	30.2
Early ripe	2.74	55.75	2,923	28
Average of above	2.57	55	3,148	28.7
Yield from mixture of seed	2.38	57	3,730	30.7
Components of mixture c.				
Russian red	2.76	55.75	2,924	28.7
Improved rice	2.52	55.25	2,759	30.4
Extra early Oakley	2.42	56.25	3,411	29.3
Crate	2.84	55.25	4,128	33.7
Average of above	2.63	55.62	3,305	30.5
Yield from mixture of seed	2.6	55.25	3,641	32.9
Components of mixture d.				
Deitz	3	55	3,948	34.5
Lebanon	3.34	57.25	3,451	30.6
Theiss	2.26	55.25	3,612	26.4
Average of above	2.87	55.8	3,670	30.5
Yield from mixture of seed	2.86	56.5	3,703	33.3

Experiment No. 53. The Effect of the time and Manner of Harvesting on the Yield of Wheat.

Three cuttings, of nine samples each, were made for the years 1891 and '92, each sample containing 200 spikes. The heads were removed from three samples of each cutting, and both straw and heads were placed in the drying room. Three were stood up in the drying room, and three were put out in the sun till thoroughly dry. Each sample was threshed, and the weights of straw and chaff, of grain, and of a certain number of kernels, were ascertained with the results found in the tables. The tabular results are each an average of three samples. In each of the two years the average yield of grain and weight of 1,000 kernels is greatest for that dried in the shade with heads on, which indicates that there is a transition of matter from straw to grain after cutting, if the heads are not removed and the drying is not too rapid. In general there is an increase in yield from the earliest to the latest cutting. These results correspond with those obtained from experiments of like character in two previous years.

WEIGHTS OF WHEAT CUT AT DIFFERENT DATES AND DRIED IN DIFFERENT WAYS, 1891-92

Date of cutting.	Stage of ripeness, when cut.	Wt. of 500 kernels, grams.			Wt. of kernels of 200 heads of wheat, grams.			Wt. of straw and chaff of 200 culms, grams		
		Heads removed.	Dried in the shade.	Dried in the sun.	Heads removed.	Dried in the shade.	Dried in the sun.	Heads removed.	Dried in the shade.	Dried in the sun.
1891 June 18	Kernels mostly in milk, some in dough stage, lower leaves dry.	8.3	8.7	8.5	77.5	85.6	80	435.2	441.9	378.5
25	Kernels mostly in dough, leaves mostly dead, lower half of stems brown....	12.3	13.4	13	114.6	123.1	122.2	395.6	381.1	378.2
29	Fully ripe........	12.9	13	13.1	117.7	120.1	120.4	371.8	372.6	367.4
1892 June 29	Kernels in milk. Straw beginning to turn in color...........	8.8	9	7.9	88.6	104.7	85.2	365.9	410.4	390.1
July 4	Kernels in dough stage...........	9.7	10	8.3	111.1	108.1	73.5	388.7	354.1	335.1
13	Fully ripe........	14	13.9	12.8	153	153.6	134.8	337.5	330.4	300.3

RELATIVE WEIGHTS OF WHEAT CUT AT DIFFERENT DATES AND DRIED IN DIFFERENT WAYS, 1891 AND 1892.

Date of Cutting.	Relative wt. [air dry] of kernels of 100 culms of wheat.				Relative wt. [air dry] of 1000 kernels.			
	Heads removed	Dried in shade.	Dried in sun.	Average-	Heads removed	Dried in shade.	Dried in sun.	Average.
1891.								
June 18	63	65.9	65	64.6	62.3	65.2	63	63.5
" 25	93.1	100	99.3	97.5	91.8	100	97.4	96.4
" 29	95.6	97.5	97.8	97	96.4	97.4	97.9	97.2
Average	83.9	87.8	87.4		83.5	87.5	86.1	
1892.								
June 29	57.6	68.2	55.4	60.4	62.1	64.	56.4	61.2
July 4	72.4	70.4	47.8	63.5	69.5	71.7	59.3	66.8
" 13	99.6	100	87.7	95.8	100	99	91.4	96.8
Average	76.5	79.5	63.6		77.5	78.2	69	

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BULLETIN NO. 23.

EXPERIMENTS WITH OATS, 1892.

This bulletin reports results of the following experiments with oats conducted in 1892:

No. 12. Oats, quantity of seed per acre.
No. 13. Oats, compact or loose seed-bed.
No. 14. Oats, time of sowing.
No. 15. Oats, depth of sowing.
No. 84. Oats, testing varieties.
No. 128. Oats, effect of time and manner of harvesting upon yield and chemical composition.

SUMMARY.

The trials were all made on the fertile, dark colored prairie soil of the Station grounds. The season was unfavorable for oats, in marked contrast with that of 1891. The yield per acre and the average weight per bushel were light. The rainfall during most of the period of growth was unusually heavy—19.67 inches for April, May, and June. In 1891 the rainfall for corresponding months was 6.51 inches. The average temperature for these three months was rather low. For July the rainfall was 2.5 inches and the average temperature 73.3°F.

RAINFALL AND TEMPERATURE.

	1878–87.* Av. of 10 years.		1889.		1890.		1891.		1892.	
	Rain, in.	Temperature.	Rain, in.	Temperature.	Rain, in.	Temperature.	Rain, in.	Temperature.	Rain, in.	Temperature.
April......	3.19	52.4°	0.61	52°	4.11	52.3°	3.54	52.8°	6.45	48.6
May.......	4.45	64.6	5 52	59.2	3.56	58.3	0.89	58.4	7.86	57.9
June	5.04	71.	6.81	65.5	3.8	74.6	2.08	72	5.36	70 6
	12.68		12.94		11.47		6.51		19.67	

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* Statistical Report, Illinois State Board of Agriculture, December, 1887.

The oats were sown broadcast by hand in all trials except in testing the effect of covering at different depths.

The yields from plats sown at different rates, from one to four bushels per acre, varied but little. In like trials for five years the smallest yields have been from seeding at the rate of 1 bu.; the next lightest, from sowing 1.5 bu.; third lightest, from sowing 4 bu.; with slight differences from seeding at rates from 2.5 to 3.5 bu. an acre.

The yield of straw, the weight of grain per bushel, and the percentage of kernel to husk have been lowest from thinnest seeding. These trials indicate that for this soil and climate, when oats are sown broadcast on fairly prepared soil, they should be sown at the rate of from 2.5 to 3.5 bu. an acre.

Trials of the effect of having the seed-bed loose, medium compact, or compact showed results slightly the best from having a medium condition. The yields from plats plowed were less than from plats disked. These results correspond with those in trials in three other years.

Trials to determine the effect of sowing at different dates showed that the best results came from the earliest seeding. Trials for four years show the best results in every way from sowing about the last of March, but with no serious loss from seeding up to April 15th.

Trials to determine the effect of covering the seed from one to six inches deep showed the best results from the shallowest covering. The average results from trials for five years show a steady decrease in yield from the shallowest to the deepest covering. In 1891 the best results came from covering two inches deep.

In tests of 59 varieties, grown on 70 plats, the average yield was 39.8 bu. an acre, with an average weight of 30.25 lb. a bu. Only three varieties gave yields over 50 bu.; 12, over 45 bu.; while 14 gave yields of less than 35 bu. an acre. These results are in strong contrast with those in 1891, when 44 varieties gave an average yield of 66.6 bu. with but one falling below 50 bu. an acre, and with an average of 33.5 lb. a bu. Comparison of varieties from results in 1892 is made the more difficult because of slight injury to several plats, and of serious injury to two plats, by army worms, and by the fact that it was impossible to secure all the grain from some plats because of the falling of the straw. Duplicate plats of each of six varieties were sown. In two cases the differences in yields of these were surprisingly great, illustrating the difficulty in deciding on the value of varieties from the yield in a single year. Pringle's progress takes the first rank for average yield for four years past, but no one variety has had anything like the same rank in all the four years.

The vitality of each lot of seed was tested. In most cases it was good, but in five lots less than 85 per cent germinated. In general the yields of the plats where the seed had not a high percentage of vitality was low. This suggests that it is worth while to test the vitality of seed oats.

The per cent of hulled kernel to berry of all varieties was 69.57; the highest, 77.43 ; the lowest, 62.8.

Slightly better results were obtained when the oats were harvested while the straw was still green and the kernels mostly in the dough stage than when the straw was mostly yellow and the kernels hard. When the oats were allowed to mature fully, the results were distinctly less satisfactory. When the sheaves were bound and shocked at once, the yield was somewhat better than when the cut straw was allowed to dry thoroughly before the sheaves were bound.

The results of all the experiments with oats tried at this Station for the last five years suggest that on the fertile soil of central eastern Illinois, with simple methods, we may expect in a series of years an average yield an acre of a little over 50 bushels of grain and about one and one-half tons of straw, the oats weighing rather less than more than the standard weight of 32 lb. a bushel; that it is not advisable to plow the land in the spring if the crop follows corn, the use of the disk harrow giving better results; that the seed should be sown near the last of March or first of April; that if sown broadcast, it is better to sow from two and one-half to three and one-half bushels per acre, covering the seed not more than one or two inches deep ; that there is no one variety greatly superior to all others, so that it is not wise to put full credence in the claims often made for new varieties ; that some varieties are, however, distinctly better than some others; that neither color or plumpness of kernels, weight per bushel, nor the form of the head certainly determines value ; but that, generally, varieties with long, slender, comparatively light kernels have the smallest percentage of husk and, probably, the greatest feeding value ; that early maturing varieties are to be preferred to those ripening later ; that it is desirable to harvest the crop before it has fully ripened ; and that binding and shocking the sheaves at once is an advantage rather than a disadvantage, if the grain is in fit condition for cutting.

Experiment No. 12. Oats, Quantity of Seed per Acre.

Two series of seven plats, each 2 x 4 rods, were sown broadcast with early Dakota oats April 11, 1892, and afterwards seeded with timothy and clover. The oats were sown at the varying rates of 1, 1.5, 2, 2.5, 3, 3.5, and 4 bu. (32 lb.) an acre, there being two plats sown at each rate. The corn stalks of the preceding year having been removed, the land was plowed about four inches deep three days before the oats were sown.

In the table giving results it will be seen that the yield of grain is quite uniform, the minimum being 39.2 bu. an acre, from a plat seeded at the rate of one bushel, and the maximum, 45.6 bu. from a plat seeded at the rate of 2.5 bu. In general the yield of straw increases with the thickness of seeding, as does also the number of stubs on a square foot. The size of berries, per cent of kernel in berries, and weight per bushel are least for the thinnest seeding and increase slightly with the thickness of seeding. The thinnest seeding was three days later in ripening than the thickest. The grass was slightly poorer on the thickest seedings, but not so much affected by the thickness as by the lodging of the oats. The lodging seemed to bear no relation to the thickness of seeding.

The table giving the yield of both grain and straw for each of the five years, 1888 to 1892, shows the maximum average yield of grain to be from seeding at the rate of 3.5 bu., with but slight differences between 2.5, 3, 3.5, and 4 bu. an acre. In three of the five years the largest yield was in favor of 2.5 bu., for the other two, in favor of 3.5 bu.

The average yield of straw is quite uniform, the maximum being slightly in favor of 3 bu.

The average weight per bushel is least for the thinnest seeding and greatest for the thickest.

YIELDS OF OATS FROM DIFFERENT RATES OF SEEDING, 1892.

Plat No.	Seed per a., bu.	Stubs per sq. ft.	Wt. 100 berries, grams.	Per cent kernel in berries.	Pounds per bu.	Yield per acre.			
						Straw, lb.	Grain, bu.	Av. of straw.	Av. of grain.
1	1	15	1.77	69.7	27	1825	39.2	1742	40.5
8	1	22	1.66	69.6	24.25	1660	41.9		
2	1.5	21	1.75	70.7	28.5	1920	45	1980	43.5
9	1.5	23	1.79	70.4	26.25	2040	41.9		
3	2	27	1.85	70.9	28	1815	42	1832	43.3
10	2	21	1.85	70.6	28.25	1850	44.7		
4	2.5	36	1.84	70.6	28 25	1930	43.4	1935	44.5
11	2.5	30	1.80	71.1	27.75	1940	45.6		
5	3	29	1.96	72.7	29.5	2205	44.8	2100	44.3
12	3	27	1.80	70.8	26.75	1995	43.9		
6	3.5	29	1.81	70.9	29.5	1930	41.6	1952	42.4
13	3.5	37	1.84	72.6	28	1975	43.3		
7	4	38	1.89	72.5	28.75	2545	41.7	2377	43.2
14	4	53	1.77	71.9	29.75	2210	44.7		

YIELDS OF OATS FROM DIFFERENT RATES OF SEEDING, 1888, '89, '90, '91, '92.

Seed per acre, bu.	Grain per acre, bu.						Straw per acre, lb.						Lb. per bu.			
	1888.	1889.	1890.	1891.	1892.	Av.	1888.	1889.	1890.	1891.	1892.	Av.	1889.	1890.	1891.	1892.
1	52.5	36.3	25.3	36.7	40.5	38.3	3820	4600	2820	1275	1742	2851	25.5	26	28.5	25.5
1.5	59.4	33.1	21.6	56.9	43.5	42.9	4400	3800	1740	1970	1980	2778	25	26.5	31	27.5
2	61.4	42.5	17.5	74.8	43.3	47.9	4540	4000	1800	2748	1832	2984	28	24	31.5	28
2.5	63.8	43.8	29.1	72 6	44.5	50.8	4860	3000	2460	2638	1935	2979	28	29	32	28
3	61.9	47.2	27.5	76.6	44.3	51.5	5220	4400	1960	2790	2100	3294	29	29	32.5	28
3.5	62.5	52.1	24.7	79.7	42.4	52.3	4400	4100	2000	3060	1952	3102	29.5	28	32	28.7
4	60.6	50.6	21.9	76.3	43.2	50.5	4260	3200	2020	3110	2377	2993	29.5	29	32	29.2

Experiment No. 13. Oats, Compact or Loose Seed-bed.

The land, 7 plats 2 by 4 rods, was in corn in 1891. April 12, 1892, the stalks were removed and early Dakota oats sown broadcast at the rate of 2.5 bu. per acre.

Plat 1 was seeded, plowed about 4 inches deep, and harrowed once slightly.

Plat 2 was seeded, disked, and harrowed.

Plat 3 was disked, seeded, harrowed, and rolled.

Plat 4 was seeded, plowed 4 inches deep, and harrowed.

Plat 5 was disked, seeded, and harrowed.

Plat 6 was seeded, disked, harrowed, and rolled.

Plat 7 was seeded and harrowed five times.

All of the plats were afterward seeded with timothy and clover and again harrowed once lightly.

In the table it will be seen that the yields are quite uniform, the maximum being 47.2 bu. from a plat that was seeded and harrowed after disking. There was no benefit derived from rolling after disking and the average yield of the two plats that were plowed was 4.5 bu. less than the average of two plats simply disked and harrowed.

In the table giving yields for four years it will be seen that for three out of the four years the maximum yield of grain was in favor of the medium seed-bed and that the average for the four years was 1.9 bu. greater from such seed-bed than from a compact seed-bed, and 4.5 bu. greater than from a loose seed-bed.

NUMBER OF PANICLES AND RELATIVE YIELD OF OATS SOWN IN DIFFERENTLY PREPARED SEED-BEDS, 1892.

Plat No.	Preparation of seed-bed.	Per cent. standing when cut.	No. stubs on one sq. ft.	Lb. per bu.	Per cent kernel in berries.	Wt. 100 berries, grams.	Yield per acre.	
							Straw, lb.	Grain, bu.
1	Plowed 4 in. deep, seeded, and harrowed..	40	33	28	71.47	1.83	2140	41.9
2	Seeded, then disked and harrowed........	98	34	29.25	70.73	1.89	2030	42.2
3	Disked, seeded, harrowed, and rolled.....	98	32	29.5	70.61	1.71	2180	43.8
4	Seeded, and then plowed four in. deep....	85	23	25.75	70.49	1.81	1755	42.7
5	Disked, seeded, and harrowed............	100	28	29.5	70.51	1.87	3170	47.2
6	Seeded, disked, harrowed, and rolled.....	95	28	29.75	73.61	1.9	2150	44.7
7	Seeded and harrowed..................	80	31	29.25	73.29	1.95	1735	40.8

YIELDS OF OATS FROM COMPACT, MEDIUM, AND LOOSE SEED-BEDS, 1888, '89, '90, '92.

Seed-bed.	1888.		1889.		1890.		1892.		Average.	
	Grain per acre, bu.	Straw per acre, lb.	Grain per acre, bu.	Straw per acre, lb.	Grain per acre, bu.	Straw per acre, lb.	Grain per acre, bu.	Straw per acre, lb.	Grain per acre, bu.	Straw per acre, lb.
Compact......................	60	4180	44.4	3200	36.3	2040	44.2	2165	46.2	2896
Medium	66.3	5380	47.8	2900	32.8	2020	45.7	2600	48.1	3225
Loose......................	60.6	4460	41.4	3300	30.3	1940	42.3	1947	43.6	2662

Experiment No. 14. Oats, Time of Sowing.

Twelve plats, each 2 by 4 rods, were sown broadcast, two each week, from March 30 to May 4, 1892. The oats, variety Pringle's progress, were sown as follows: plats 1, 5, 8, 10 and 12 at the rate of 3⅛ bu. (32 lb.) an acre; the remaining plats at the rate of 2.5 bu. The land was in corn in 1891. The stalks were removed and the entire tract plowed about 4 inches deep just before the earliest seeding. Each plat was disked and harrowed after seeding.

In the table giving results it will be seen that the time of ripening was delayed one day for each week's delay in seeding; that, in general, the yield of straw and grain decreased with the lateness of seeding; that the weight per bushel and per cent of kernel in the berries uniformly decreased with the lateness of seeding; and that, in four out of five

YIELDS OF OATS FROM SOWINGS AT DIFFERENT TIMES, 1892.

Date of sowing.	Ripe, July.	Plat No.	Yield, per acre.		Pounds per bu.	Per cent kernel in berries.	Plat No.	Yield per acre.		Pounds per bu.	Per cent kernel in berries.	Average.			
			Straw, lb.	Grain, bu.				Straw, lb.	Grain, bu.			Yield per acre. Straw, lb.	Yield per acre. Grain, bu.	Pounds per bu.	Per cent kernel in berries.
March 30.	22	1	1560	45	27.75	69.57	7	1975	47	28.25	69.73	1767.5	46	28	69.65
April 6.	23	2	1580	43.1	27.5	69.06	8	1460	41.8	27.25	68.31	1520	42.4	27.37	68.68
April 13.	24	3	1505	49.8	26	65.25	9	1380	45.6	27.25	67.32	1442.5	47.7	26.62	66.28
April 21.	25	4	1325	43.5	26.25	68.63	10	1340	40	24.25	62.72	1332.5	41.7	25.25	65.67
April 27.	26	5	1470	40.3	24.25	61.41	11	1495	44.5	25.5	66.2	1482.5	42.4	24.87	63.8
May 4.	27	6	1320	18.1	17.25	52.02	12	1330	29.7	20.5	61.23	1325	23.9	18.87	56.62

YIELDS OF OATS FROM SOWINGS AT DIFFERENT TIMES, 1888, '89, '90, '92.

Date of Sowing.	1888.		1889.			1890.			1892.			Average		
	Yield per acre.		Lb. per bu.	Yield per acre.		Lb. per bu.	Yield per acre.		Lb. per bu.	Yield per acre.		Lb. per bu.	Yield per acre.	
	Straw, lb.	Grain, bu.		Straw, lb.	Grain, bu.		Straw, lb.	Grain, bu.		Straw, lb.	Grain, bu.		Straw, lb.	Grain, bu.
March 14.	....	....	28.5	3600	48.1	....	....	....	.....	......	....	.....	......	....
March 22.	....	....	28	4600	41.5	31.8	3140	44.1	.....	......	....	29.9	3870	42.8
March 28-31.	....	....	28.5	5200	41.3	31	3390	45.1	28	1767.5	46	29.1	3452.5	44.1
April 4-7.	5080	66.3	26.5	4000	36.3	27	2890	36.5	27.37	1520	42.4	26.95	3372.5	42.8
April 11-16.	5020	56.5	25	4000	33.1	27.3	3020	30	26.62	1442.5	47.7	26.3	3370.6	41.8
April 18-21.	5040	48.8	22	4100	25	26.8	2740	28.1	25.25	1332.5	41.7	24.68	3303.1	35.9
April 25-28.	5020	49.4	21	3700	9.4	26.8	2540	19.6	14.87	1482.5	42.4	20.89	3185.6	30.2
May 4.	....	....	....	...	....	....	....	....	18.87	1325	23.9	.....	......	....

cases, where the two plats sown at the same time were sown at different rates, the larger yield was in favor of the thinner seeding.

The table giving yields for each of four years shows that in general the earliest seedings yield best. Taking the average for four years the maximum yield of grain is in favor of seeding March 28th to 31st with but little difference any time between March 22d and April 16th.

The weight per bushel uniformly decreases with the lateness of seeding.

Experiment No. 15. Oats, Depth of Sowing.

April 16, 1892, sixty selected kernels were planted in each of twelve rows 10 ft. long. Rows 1 and 2 were covered one inch deep, and each succeeding two rows one inch deeper, rows 11 and 12 being covered six inches deep. There was an extra row on either side. The table gives the number of plants started, number of panicles harvested, weight of grain, and weight of 100 kernels for each row. In general there is a decrease from the shallowest to the deepest planting.

YIELDS OF OATS FROM SOWINGS AT DIFFERENT DEPTHS, 1892.

Depth of sowing, inches.	Row No.	No. plants started.	No. panicles harvested.	Wt. grain, grams.	Wt 100 kernels, grams.
1	1	60	182	191.5	1.87
1	2	60	177	226	1.9
2	3	56	141	178	2.17
2	4	59	181	211.3	1.95
3	5	57	147	184.1	2.01
3	6	57	146	166	1.92
4	7	56	159	147.7	1.7
4	8	58	184	173	1.72
5	9	58	165	149.2	1.57
5	10	60	190	167.2	1.66
6	11	53	159	129.4	1.7
6	12	56	152	133.6	1.82

YIELDS OF OATS FROM SOWINGS AT DIFFERENT DEPTHS, 1888, '89, '90, '91, 92.

Depth of sowing, inches.	1888.		1889.		1890.		1891.		1892.		Average.	
	No. of panicles.	Relative yield.	No. of panicles.	Relative yield.	No. of panicles.	Relative yield.	No. of panicles.	Relative yield.	No of panicles.	Relative yield.	No. of panicles.	Relative yield.
1	566	90	407	81	362	100	205	69	179.5	100	344	88
2	495	80	424	69	312	76	338	100	161	94	346	84
3	465	100	434	76	307	65	192	49	146.5	85	309	75
4	469	95	439	100	269	65	188	55	171.5	77	307	60
5	481	80	.....	....	181	29	136	26	177.5	51	244	46
6	445	55	.....	.....	75	12	91	18	155.5	63	191	37

The foregoing table giving results for each of five years shows the average relative yield to be in favor of covering one inch deep, with a uniform decrease in yield for each succeeding inch.

Experiment No. 84. Oats, Test of Varieties.

In 1892 a test was made of 59 varieties of oats, or 59 samples of oats each having a different name. Duplicate plats were sown of each of six varieties, and five plats were sown with mixtures of several varieties. In all 70 plats were sown, each two by four rods, or one-twentieth of an acre. These were all in one tract of land nearly square, and apparently as uniform in quality as a tract of such size is likely to be. The land had been in corn in 1891. The stalks were burned about the first of April. Each plat was sowed with four pounds of oats, or at the rate of two and one-half bushels an acre by weight, the sowing being done by hand. The ground was first disked. Except three, all the plats were sown April 11th to 13th. All the plats were disked after the sowing, and the whole tract was twice harrowed after being sown with timothy and clover, April 15th, 16th. The three extra plats were sown April 16th. The slight difference in time of sowing made no perceptible difference in yield. The weather was fairly favorable and the soil in moderate condition as to dryness. Excessive rains began soon after, continuing until the middle of June.

The vitality of the seed of each variety was tested in the Geneva apparatus. Nine varieties showed perfect germination power; of nine varieties the per cent germinating was less than 90, the lowest, 74; next lowest 80. The average yield of the nine with highest per cent was four bushels per acre more than the average of the nine with lowest germinating power.

The harvest was unusually late, the oats being cut from July 23rd to August 4th. In 1891 harvest began July 6th and was completed July 24th, with the exception of one variety.

DUPLICATE PLATS.

Duplicate plats were sown of each of six varieties, the plats being distributed over the tract as well as practicable. The results are given in the table. In three cases the difference in yield was less than two bushels per acre; in three, from four to eight bushels. There were striking differences in average height and weight per bushel. These differences in results from plats of the same varieties, where the attempt was made to have treatment alike; emphasize the need of caution in drawing conclusions from results of variety tests. (*See table, p. 129*).

YIELD.

The average yield of grain for the 70 plats was 39.9 bu. an acre. Not counting three plats, two of which were much injured by the army worm, and the third of a variety unsuited to this climate, the average yield was at the rate of 40.7 bu. an acre. In 1891 fifty-five plats gave

YIELD OF DUPLICATE PLATS OF OATS, 1892.

Name of variety.	Yield per acre		Lb. straw for each lb. grain.	Lb. per bu.....	Height, inches.	No. stubs per sq. ft......	Weight 100 berries, grams.	Per cent. kernel in berries.
	Grain, bu.	Straw, lb.						
Pringle's progress.........	48.8	2319.2	1.48	30.25	49	34	2.14	72.65
" "	53.9	2206.8	1.28	29.75	48	31	2.12	73.15
Calgarry gray.............	46.3	1578.2	1.06	32	38	34	2.09	76.44
" "	54.5	2214.2	1.27	33	47	37	2.08	77.43
Bicket's Columbia.........	42.3	1635.6	1.21	28.5	39	32	2.32	74.21
" "	41.7	2274.2	1.7	31.5	48	28	2.17	73.09
Texas rust proof	40.2	1942.4	1.51	31.25	46	36	2.55	74.48
" " "	42.2	1460	1.08	27.5	36	28	2.53	73.28
White bonanza............	39.2	1871	1.49	33.5	39	21	2.5	68.09
" "	40.15	2229.2	1.73	35.25	45	24	2.57	68.24
Welcome.................	41.6	2643.4	1.98	34.75	48	32	2.3	72.34
"	37.5	1718.6	1.36	32.75	47	26	2.29	67.5

an average yield of 66.6 bu. an acre. The average yield of straw in 1892 was at rate of 2025 lb. an acre, compared with 2840 lb. in 1891. The largest yield was 56.3 bu. an acre. Three varieties gave yields over 50 bu.; nine, between 45 and 50; seventeen, between 40 and 45; twenty-one, between 35 and 40; six, between 30 and 35; and eight, less than 30 bu. per acre. Slight injury was done to several plats by army worms, but this was not serious except in the case of two plats which gave the smallest yields. The difference in condition of the plats as to lodging of the straw affected the yield. The average per cent of husked kernel to berry was 70.34 in the seed and 69.57 in the crop. In each case the average was lower than that for the crop of 1891. The feeding value of oats, obviously, largely depends on the percentage of husked kernel to the whole berry. There are striking differences in this respect, but these differences are not constant. Almost without exception, however, varieties with short, plump kernels, show a larger per cent of husk than those with long, slender kernels.

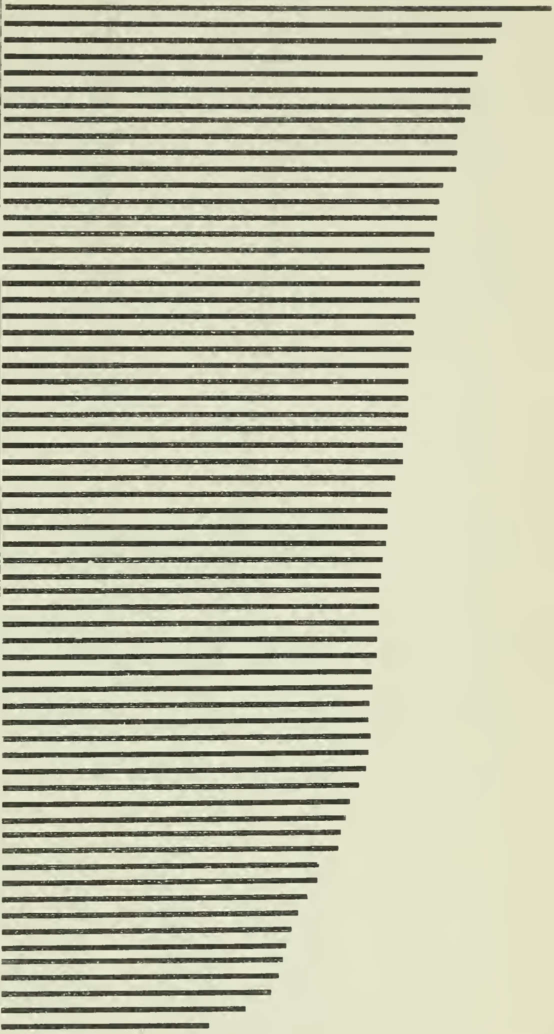
Tests of varieties for four years [*p. 134*] have failed to show that any one variety is superior to all others in any marked degree. No variety has had the same rank for the fouryears. Pringle's progress stands highest. For three years out of the four it has given the second largest yield, and the average yield for the four years is nearly three bushels larger than that of New Dakota gray, which stands second. Following these are seven varieties, the average yields of which for the four years vary scarcely more than one bushel an acre. There are 12 or 15 varieties, the average yields of which vary less than trials show may be expected where the same variety is treated on different plats. Among these are varieties ripening at different times, differing in color, shape of head, etc. Early ripening varieties have obvious advantages over those which ripen late. The variety known as Virginia winter is not

SYNOPSIS OF VARIETIES.

						Yield, bu.	Av.
Oats.	Early.	Panicles open	White	Long	Pringle's progress	57.3	44.7
					Early Dakota	38.2	
				Short	White wonder	45.03	38.4
					Second premium	34.9	
					Early Lackawana	28.1	
					White bonanza	39.6	
					Welcome	39.5	
					Badger queen	32.5	
					Clydesdale	35.7	
					Canada white	35.8	
					White Victoria	37.9	
					Hopetown	29.5	
					White Belgian	29.2	
					Prize cluster	40.9	
					Hargett's white	37.9	
					Centennial	41.2	
					Race horse	38.8	
					Early Archangel	48.7	
			Black	Long	Calgarry gray	50.4	47.3
					Black Russian	44.2	
			Dun	Long	Texas rust proof	42.2	
	Medium.	Panicles open	White	Long	Simpson	39.	43.8
					Swedish	39.2	
					American banner	48	
					White schonen	41.8	
					Improved American	47.6	
					Improved white Russian	43.9	
					White Russian	41.8	
					Shropshire	49.1	
					Scottish chief	44.4	
				Short	White Swede	37.7	35.1
					Egpytian	17.9	
					Wide awake	44.8	
					Prolific side	43.5	
					Pride of Grant county	48.1	
					Thousand fold	29.8	
					Surprise	28.7	
					Royal Victoria	38.9	
					Victoria	36.3	
			Dun	Long	Texas rust proof	40.2	
		Panicles closed	White	Short	Baltic white	37.9	34.5
					Japan	39.1	
			Black	Long	Black prolific	46.6	
	Late.	Panicles open,	White	Long	American triumph	32.8	37.8
					Common mixed	38	
					Seizure	42.8	
				Short	Probsteir	21.6	32.8
					Bicket's Columbia	42	
					Hungarian hybrid	37.8	
			Black	Long	Black Highlander	38.3	37.4
					Canadian black	30.8	
					Prince Edward's Island	43.1	
			Dun	Long	New red rust proof	56.3	41.1
					Texas red	41.7	
					Virginia winter	25.4	
		Panicles closed	White	Long	Giant yellow French	37.4	41.9
					Golden giant side	46.4	
			Black	Long	New Dakota gray	41.7	41.4
					Black Tartarian	42.6	
					Dakota	39.9	

adapted to this climate. The variety called Simpson has been grown on one farm near Clinton, Ill., for more than 35 years. It gave about an average yield, was of light weight, with a good percentage of hulled kernel. This is of interest from the fact that central Illinois is not

COMPARATIVE YIELD OF VARIETIES OF OATS, 1892.

Plat No.	Name of variety.	Bu.	Comparative yield.
36	New red rust proof......	56.3	
39 & 1	Pringle's progress (Av.).	51.3	
38 & 7	Calgarry gray (Av.)......	50.4	
58	Shropshire	49.1	
64	Early Archangel........	48.7	
60	Pride of Grant county...	48.1	
26	American banner......	48	
35	Improved American....	47.6	
42	Black prolific...........	46.6	
56	Mixture................	46.6	
54	Golden giant side.......	46.4	
2	White wonder...........	45	
33	Wide awake....	44.8	
61	Scottish chief...........	44.4	
46	Black Russian...........	44.2	
48	Improved white Russian	43.9	
34	Prolific side............	43.5	
59	Prince Edward's Island.	43.1	
68	Seizure.................	42.8	
43	Black Tartarian.........	42.6	
19	Mixture................	42.4	
44 & 13	Bicket's Columbia (Av.)	42	
30	White schonen..........	41.8	
52	White Russian..........	41.8	
37	Texas red...............	41.7	
29	New Dakota gray.......	41.7	
22	Centennial.............	41.2	
25 & 70	Texas rust proof (Av.)...	41.2	
20	Prize cluster............	40.9	
69	Dakota..................	39.9	
6 & 8	White bonanza (Av.)....	39.6	
45	Mixture................	39.5	
47 & 9	Welcome (Av.)..... ...	39.5	
23	Swedish................	39.2	
28	Japan..................	39.1	
10	Mixture.................	39	
62	Simpson................	39	
66	Royal Victoria..........	38.9	
40	Race horse.............	38.8	
49	Black Highlander.......	38.3	
41	Mixture................	38.2	
15	Early Dakota............	38.2	
55	Common mixed.........	38	
16	White Victoria..........	37.9	
21	Hargett's white........	37.9	
27	Baltic white..	37.9	
53	Giant yellow French....	37.4	
67	Victoria................	36 3	
14	Canada white..........	35.8	
12	Clydesdale.............	35.7	
3	Second premium........	34.9	
57	Hungarian hybrid.......	34.8	
4	White Swede...........	34.7	
32	American triumph......	32.8	
11	Badger queen...........	32.5	
51	Canadian black.........	30.8	
63	Thousand fold..........	29.8	
17	Hopetown..............	29.5	
18	White Belgian..........	29.2	
65	Surprise	28.7	
5	Early Lackawana.......	28.1	
50	Virginia winter.........	25.4	
31	Probstier...............	21.6	
24	Egyptian...............	17.9	

thought to have a climate favorable for the production of oats of the best quality.

The lessons from these variety tests are negative rather than positive. We may safely distrust the statements by seedsmen that their favorite variety will certainly give phenomenally large crops. Conclusions from the results of the trials in 1892 should be drawn with more than usual caution, because of the very different behavior of different varieties as to lodging, and the fact that some injury was done to several plats by army worms.

RESULTS OF VARIETY TESTS OF OATS, 1892.

Plat No.	Variety.	Source of Seed.	Per cent germinated.	Yield per acre		Lb. straw per bu. grain.	Pounds per bu.	Height, inches.	Ripe, July	Weight 100 berries, grams.		Per cent kernel in berries.		Stubs per sq. ft.	Per cent standing when cut....
				Grain, bu.	Straw, lb.					In seed.	In crop.	In seed.	In crop.		
1	Pringle's progress.	Henry Maule, Philadelphia	100	48.8	2319.2	1.48	30.25	49	27	2.15	2.14	74.4	72.65	34	85
2	White wonder....	S. Wilson, Mechanicsville, Pa.......	86	45.03	2079	1.44	31.25	48	27	2.21	2.15	69.1	71.59	34	100
3	Second premium.	Station, 1891	100	34.9	2421.6	2.16	38	50	25	2.89	2.72	67.3	71.02	26	75
4	White Swede.....	Currie Bros., Milwaukee...	92	34.7	1839.8	1.66	30.75	45	30	2.13	2.37	65.2	73.66	31	50
5	Early Lackawana.	Station, 1891	100	28.1	1796.8	1.98	29.75	44	27	2.3	2.2	68.3	70.74	30	0
6	White bonanza...	S. Wilson, Mechanicsville, Pa	90	39.2	1871	1.49	33.5	39	25	2.68	2.5	62.7	68.09	21	0
7	Calgarry gray....	J. H. Beagley, Sibley, Ill..	98	46.3	1578.2	1.06	32	38	23	2.16	2.09	75.2	76.44	34	100
8	White bonanza...	J. C. Vaughan, Chicago ...	98	40.15	2229.2	1.73	35.25	45	26	2.93	2.57	67.5	68.24	24	10
9	Welcome	Station, 1891	100	41.6	2643.4	1.98	34.75	48	26	2.55	2.3	70.4	72.34	32	90
10	Mixture *a*........	....	......	39	2473	1.9	32.5	48	26	2.36	2.27	70.8	73.06	29	75
11	Badger queen.....	Currie Bros., Milwaukee ..	80	32.5	2005	1.93	34.75	47	26	3.06	2.49	65.5	67.35	28	0
12	Clydesdale.......	H. A. Dreer, Philadelphia.	92	35.7	2003.4	1.75	32.5	45	26	2.74	2.48	69.7	68.93	26	40
13	Bicket's Columbia	W. A. Bicket, Sibley, Ill...	98	42.3	1635.6	1.21	28.5	39	31	2.21	2.32	71.1	74.21	32	90
14	Canada white....	Station, 1891.............	98	35.8	1825.4	1.59	33.25	43	26	2.56	2.39	70.3	66.54	31	75
15	Early Dakota	W. W. Barnard, Chicago..	88	38.2	2403.2	1.97	34	45	25	2.57	2.39	67.2	68.16	26	65
16	White Victoria ...	Station, 1891	98	37.9	2796.6	2.3	33.5	48	25	2.57	2.34	74	69.61	31	65
17	Hopetown	P. Henderson & Co., N. Y.	94	29.5	2464.8	2.6	32.25	48	23	2.76	2.19	72	64.16	24	0
18	White Belgian....	Station, 1891	88	29.2	2206.8	2.37	33	49	23	2.75	2.17	66.5	64.65	26	0
19	Mixture *b*........	....	......	42.4	1911.2	1.41	34	51	23	2.47	2.47	65.9	69.29	31	25
20	Prize cluster	Currie Bros., Milwaukee...	98	40.9	2202.4	1.68	30.75	44	27	2.29	2.23	68.5	67.39	30	65
21	Hargett's white...	Station, 1891..............	98	37.9	1876.6	1.54	32.25	41	25	2.66	2.24	65	67.19	25	65
22	Centennial.......	" "	98	41.2	2735.6	2.08	34.5	48	26	2.56	2.32	69.1	70.83	29	10
23	Swedish	" "	100	39.2	2182	1.74	31.25	46	30	2.56	2.34	71.7	73.74	26	98
24	*Egyptian	" "	96	17.9	2521.8	4.39	31.5	51	30	2.5	2.18	71.3	67.41	28	40
25	Texas rust proof..	" "	98	40.2	1942.4	1.51	31.25	46	30	2.6	2.55	75.5	74.48	36	85
26	American banner.	J. C. Vaughan, Chicago....	98	48	2063	1.34	30.75	45	30	2.53	2.43	66.5	68.2	28	100
27	Baltic white......	Station, 1891	100	37.9	2430.4	2	32.25	38	30	2.54	2.3	70.5	66	26	75
28	Japan	W. W. Barnard, Chicago..	92	39.1	1973.2	1.57	29.25	45	30	2.26	2.19	66.9	67	24	70
29	New Dakota gray.	Station, 1891.............	96	41.7	2283.4	1.71	24.5	49	†1	2.43	2.15	69.4	65.3	21	25
30	White schonen...	" "	96	41.8	1908.2	1.41	29.25	48	30	2.51	2.42	74.1	73.03	26	100

31	*Probstier	P. Henderson & Co., N. Y.	90	21.6	2755.2	3.87	31.5	50	†2	2.65	2.17	68.7	67.35	24	75
32	American triumph	Henry Dreer, Philadelphia.	92	32.8	2518.6	2.39	25	48	†1	2.39	1.82	67.3	65.27	29	50
33	Wide awake	J. C. Vaughan, Chicago	100	44.8	1727	1.21	28.75	41	30	2.46	2.18	71.8	71.77	25	75
34	Prolific side	S. Wilson, Mechanicsville, Pa	84	43.5	1782.2	1.28	28	47	30	2.35	2.16	67.4	65.52	26	90
35	Imp. American	J. Harris & Co., Morton Farm, N. Y.	100	47.6	1546.4	1.01	26.25	45	30	3.03	2.32	74.4	69.64	28	75
36	New red rust proof	Station, 1891	96	56.3	1701	.94	30	43	31	2.86	2.08	72.5	74.13	33	50
37	Texas red	" "	100	41.7	1845.4	1.38	32	47	31	2.62	2.51	74.7	72.7	36	100
38	Calgarry gray	J. H. Beagley, Sibley, Ill.	98	54.5	2214.2	1.27	33	47	25	2.16	2.08	75.2	77.43	37	100
39	Pringle's progress.	Henry Maule, Philadelphia	100	53.9	2206.8	1.28	27.75	48	27	2.15	2.12	74.4	73.15	31	75
40	Race horse	J. C. Vaughan, Chicago	96	38.8	2142.4	1.72	31.25	51	26	2.45	2.15	63.4	64.97	26	0
41	Mixture *c*			38.2	1655	1.35	25	43	30	2.26	2.1	72.8	69.45	31	25
42	Black prolific	Currie Bros., Milwaukee	98	46.6	1843.4	1.25	25.5	48	30	2.39	1.93	72.3	67.05	25	25
43	Black Tartarian	P. Henderson & Co., N. Y.	78	42.6	2072	1.52	25	49	†1	2.96	2.06	71.9	66.05	24	70
44	Bicket's Columbia	W. A. Bicket, Sibley, Ill.	98	41.7	2274.2	1.70	31.5	48	†2	2.21	2.17	71.1	73.09	28	100
45	Mixture *d*			39.5	1974.6	1.56	28.5	46	30	2.73	2.4	71.9	70.73	27	100
46	Black Russian	S. F. Leonard, Chicago	98	44.2	1582.8	1.12	30.5	42	23	2.07	2.07	76.2	74.37	24	75
47	Welcome	University farm	84	37.5	1718.6	1.36	32.75	47	26	2.33	2.29	71	67.5	26	50
48	Imp. white Russian	Currie Bros., Milwaukee	94	43.9	1648.4	1.17	28.75	40	27	2.01	2.08	72.3	72.22	28	100
49	Black Highlander.	Station, 1891	98	38.3	1680.2	1.37	24.5	43	30	2.54	2.05	68.9	64.02	32	70
50	Virginia winter	" "	96	25.4	2018.2	2.48	27	48	†2	2.41	1.8	78.8	69.19	29	50
51	Canadian black	" "	94	30.8	1915.2	1.94	28.25	45	†4	2.28	1.8	76.3	72.47	30	100
52	White Russian	N. B. & G. Co., Minneapolis	96	41.8	1683.6	1.03	30	44	30	2.50	2.34	73.8	72.03	31	100
53	Giant yellow French	J. C. Vaughan, Chicago	96	37.4	1746.2	1.46	24.25	44	†2	2.2	2.34	69.1	67.31	36	95
54	Golden giant side.	N. B. & G. Co., Minneapolis	82	46.4	2250	1.51	24	48	†1	3.09	1.95	73.2	65.9	27	90
55	Common mixed	Station, 1891	88	38	1463	1.11	26	40	†2	2.63	1.94	66.8	63.37	25	80
56	Mixture *e*			46.6	1728.4	1.16	27	47	30	2.79	2.2	73.5	69.95	27	100
57	Hungarian hybrid	R. Shedden, Pingree Grove, Ill.	96	34.8	2559.4	2.2	30.75	48	†1	3.36	2.18	72.6	64.48	22	75
58	Shropshire	Jas. Bickerdike, Griggsville, Ill.	98	49.1	2193.4	1.39	31.75	46	30	2.11	2.08	72	73.84	48	100
59	Prince Edward's Island	Station, 1891	98	43.1	2310.6	1.68	27.75	45	31	2.38	2.17	69.8	67.83	33	100
60	Pride of Grant county	Wood Bros., Glen Haven, Wis.	96	48.1	1718.4	1.11	31	42	29	2.54	2.43	72.7	71.27	25	100
61	Scottish chief	" " "	98	44.4	1874.6	1.32	30	42	27	2.09	1.79	68.7	71.83	26	100
62	Simpson	J. Ziegler, Clinton, Ill.	96	39	1497.4	1.19	28.25	41	27	1.89	2.03	75.6	70.82	44	100
63	Thousand fold	J. A. Salzer, La Crosse, Wis	74	29.8	1673	1.75	32.5	41	30	1.96	2.35	57.7	67.59	29	100
64	Early Archangel	N. B. & G. Co., Minneapolis	92	48.7	2363	1.52	34.75	48	25	2.76	2.39	75.1	74.55	32	75
65	Surprise	Weeber & Don, N. Y.	92	28.7	2118	2.31	32	45	30	2.56	2.32	68.4	68.18	31	75
66	Royal Victoria	S. F. Leonard, Chicago	90	38.9	2045.2	1.64	35.5	48	27	2.3	2.57	64.6	68.13	28	10
67	Victoria	R. Shedden, Pingree Grove, Ill	94	36.3	1951.2	1.68	32.75	45	27	2.64	2.88	65.7	67.28	25	50
68	Seizure	Exp. Sta., Columbus, Ohio.	96	42.8	1837	1.34	24	42	†2	2.09	1.87	71.3	71.02	30	100
69	Dakota	" " "	94	39.9	1804	1.41	23.5	42	†1	2.35	1.78	66.7	62.8	26	90
70	Texas rust proof.	David Landreth, Philadel.	90	42.2	1460	1.08	27.5	36	25	2.46	2.53	71.8	73.38	28	100

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* Badly damaged by the army worm.

† August.

The seed of the mixtures *a*, *b*, *c*, *d*, *e* was composed of equal parts of the following varieties: mixture *a*, Pringle's progress and early Dakota; *b*, white bonanza, white Swede, early Lackawanna and second premium; *c*, black Russian and new Dakota gray; *d*, new Dakota gray and improved American; *e*, white Russian and golden giant side. [*See also table on p. 135.*]

YIELD OF THIRTY VARIETIES OF OATS TESTED FOUR YEARS.

Name of Variety.	Grain per acre, bu.								
	1889.		1890.		1891.		1892.		Average.
	Rank.	Bu	Rank.	Bu.	Rank	Bu.	Rank.	Bu.	
Pringle's progress	20	40	3	48.1	2	79	2	51.3	54.6
New Dakota gray	17	41.3	7	39.4	1	85	11	41.7	51.8
Japan	4	47.5	6	40.3	4	75.8	17	39.1	50.7
New red rust-proof	23	36.9	4	45	21	64.6	1	56.3	50.7
Early Dakota	2	51.3	2	48.8	23	63.7	18	38.2	50.5
Texas rust-proof	30	30	1	55.9	8	72.2	13	41.2	49.8
Improved American	3	50.3	29	25.5	5	75.2	4	47.6	49.6
American Banner	7	46.3	25	30.6	26	73.4	3	48	49.6
Black Russian	14	42.5	5	40.6	10	70.8	8	44.2	49.5
Giant yellow French	1	53.8	17	34.4	15	69.2	21	37.4	48.7
White bonanza	6	46.3	10	37.5	13	70.3	15	39.6	48.4
Prize cluster	11	42.8	11	37.2	12	70.5	14	40.9	47.8
Welcome	12	42.6	8	38	17	68.4	16	39.5	47.1
White Russian	10	43.4	28	26.6	3	76.4	10	41.8	47
Black prolific	24	36.9	13	35.9	16	68.7	5	46.6	47
Clydesdale	8	44.1	22	33.8	7	73.1	22	35.7	46.7
Common mixed	5	47.2	24	31.9	18	67.2	19	38	46.1
Badger queen	18	40.6	9	37.8	11	70.6	24	32.5	45.4
White wonder	16	42.1	16	35.6	26	58.7	6	45	45.3
Wide awake	9	43.8	26	28.6	27	58.3	7	44.8	43.9
Hopetown	15	42.1	12	35.9	18	67.7	26	29.5	43.8
Centennial	22	36.9	23	33.4	24	62.3	12	41.2	43.4
Hargett's white	21	37.2	18	34.4	25	61.1	20	37.9	42.6
American triumph	25	35.6	27	27.8	14	69.7	23	32.8	41.5
White Belgian	28	31.9	21	33.8	9	70.9	27	29.2	41.4
Black Tartarian	29	30.6	20	33.8	28	58.3	9	42.6	41.3
Probstier	19	40	15	35.6	20	65	29	21.6	40.5
Egyptian	13	42.5	14	35.9	22	64.1	30	17.9	40.1
Canadian black	26	33.8	19	34.4	29	55.7	25	30.8	38.7
Virginia winter	27	32.2	30	20	30	15.9	28	25.4	23.4

Experiment 128. Time and Manner of Harvesting.

For each of the years 1891 and 1892 trials have been made to determine the effect of time and manner of harvesting oats. In the table is given for each year the average results from six plats harvested early, six when medium ripe, six when fully ripe, and of six plats which were bound and shocked soon after cutting, six cut and allowed to dry thoroughly in the swath before being bound, and of six where the heads were cut off, leaving most of the stalk standing. There are no very striking differences shown, except in the case of the plats cut late in 1892. This result was in part due to the fact that some of these plats were not so favorably situated as some of the others in the experiment. In each year the best results were obtained where the sheaves were bound and shocked soon after cuttting. The explanation is not readily given, but the facts seem to show that this ordinary practice is a good one. Striking differences in the yield in the two years are shown, and equally striking differences in the weight per bushel. The variety was not the same. In 1891 welcome oats were used, in 1892 Pringle's progress.

*YIELD OF OATS, FORTY-FOUR VARIETIES TESTED THREE YEARS.

Variety.	1890.		1891.		1892.		Average.
	Rank.	Bu.	Rank	Bu	Rank.	Bu.	
Pringle's progress	4	48.1	3	79	2	51.3	59.5
Texas rust proof	1	55.9	10	72.2	16	41.2	56.4
New Dakota gray	9	39.4	1	85	15	41.7	55.4
New red rust proof	5	45	28	64.6	1	56.3	55.3
Black Russian	7	40.6	13	70.8	9	44.2	51.9
Japan	8	40.3	5	75.8	21	39.1	51.7
American banner	28	30.6	7	73.4	3	48	50.7
Texas red	2	49.7	34	60.8	15	41.7	50.7
Black prolific	16	35.9	19	68.7	5	46.6	50.4
Early Dakota	3	48.8	31	63.7	23	38.2	50.2
Improved white Russian	31	26.5	2	80.3	10	43.9	50.2
Prize cluster	13	37.2	15	70.5	17	40.9	49.5
Improved American	32	25.5	6	75.2	4	47.6	49.4
Second premium	6	41	11	72	29	34.9	49.3
Golden giant side	22	33.2	21	68	6	46.4	49.2
White bonanza	12	37.5	16	70.3	18	39.6	49.1
Welcome	10	38	20	68.4	19	39.5	48.6
White Russian	30	26.6	4	76.4	14	41.8	48.3
Clydesdale	20	33.8	8	73.1	28	35.7	47.5
White Victoria	13	36.9	24	66.6	25	37.9	47.1
Prince Edward's Island	24	32	24	66.2	12	43.1	47.1
Giant yellow French	19	34.4	18	69.2	26	37.4	47
Badger queen	11	37.8	14	70.6	32	32.5	47
White schonen	25	31.9	23	67.2	14	41.8	47
Baltic white	18	35.3	23	67.2	25	37.9	46.8
Black Highlander	15	36.3	26	65.9	22	38.3	46.8
White wonder	17	35.6	35	58.7	7	45	46.4
Centennial	21	33.4	32	62.3	16	41.2	46
White Swede	26	31.1	9	72.3	30	34.7	46
Common mixed	25	31.9	23	67.2	24	38	45.7
Canada white	14	36.4	30	63.9	27	35.8	45.4
Prolific side	18	35.3	37	56.7	11	43.5	45.2
Swedish	27	30.9	27	65	20	39.2	45 [illegible]
Black Tartarian	20	33.8	36	58.3	13	42.6	44.9
White Belgian	20	33.8	12	70.9	35	29.2	44.6
Hargett's white	19	34.4	33	61.1	25	37.9	44.5
Hopetown	16	35.9	22	67.7	34	29.5	44.4
Wide awake	28	28.6	36	58.3	8	44.8	43.6
American triumph	29	27.8	17	69.7	31	32.8	43.4
Early Lackawana	23	32.8	25	66.2	36	28.1	42.4
Probstier	17	35.6	27	65	38	21.6	40.7
Canadian black	19	34.4	38	55.7	33	30.8	40.3
Egyptian	16	35.9	29	64.1	39	17.9	39.3
Virginia winter	33	20	39	15.9	37	25.4	20.4

* This table goes with table on p. 134.

VARIETIES OF OATS CLASSIFIED AS TO YIELD, WEIGHT, PER CENT OF KERNEL, 1892

Classification.	No. of plat.	Yield per acre.		Lb. straw for each lb. grain.	Lb. per bu.	No. stubs one sq. ft.	Height, in.	Wt. of 100 berries, grams.		Per cent of kernel in berries.	
		Grain, bu.	Straw, lbs.					In seed.	In crop.	In seed.	In crop.
Maturing early	27	40.15	2131	1.69	32.65	29	46	2.5	2.31	69.8	70.09
Maturing medium	25	40.2	1901	1.56	29.91	29	44	2.42	2.28	70.05	70.05
Maturing late	18	38.75	2039	1.73	27.1	29	45	2.54	2.06	71.14	68.13
Berries, short plump	33	36.8	2141	1.91	32.42	27	46	2.54	2.33	68.4	68.6
Berries, long slender	37	42.5	1921	1.43	28.3	30	44	2.42	2.14	72.1	70.41
Berries, white	53	39.25	2072	1.72	31.01	28	46	2.49	2.27	69.5	69.3
Berries, black,	12	41.8	1909	1.43	27.33	29	45	2.39	2.06	72.2	69.49
Berries, dun-colored	5	41.2	1793	1.49	29.55	32	44	2.59	2.29	74.7	72.7
Panicles, open	58	39.36	2028	1.69	31	29	45	2.47	2.26	70.2	70.1
Panicles, closed	12	42.05	2007	1.49	26.58	27	46	2.51	2.13	71.05	67.5
Wt. per bu., 32 lb. or more	25	38.2	2152	1.79	33.5	29	46	2.56	2.38	68.9	69.4
Wt. per bu., less than 32 lb.	45	40.7	1954	1.58	28.44	29	45	2.43	2.15	71.2	69.7
Wt. of seed per 100 berries, 2.25 grams or more	54	38.7	2065	1.74	30.78	28	46	2.59	2.27	76.1	68.7
Wt. of seed per 100 berries, less than 2.25 grams	16	43.6	1887	1.36	29.8	33	44	2.11	2.13	71.2	72.6
Kernel in seed, 70% or more	39	41.7	1999	1.57	29.8	29	45	2.47	2.2	73.1	71.1
Kernel in seed, less than 70%	31	37.4	2057	1.77	30.7	28	46	2.48	2.28	66.9	67.7
Kernel in crop, 70% or more	31	42.92	1976	1.45	30.7	31	45	2.36	2.23	72.2	72.8
Kernel in crop, less than 70%	39	37.35	2063	1.82	29.8	27	46	2.57	2.24	68.8	66.98

EFFECT OF TIME AND MANNER OF HARVESTING OATS AT DATES AND UNDER CONDITIONS GIVEN.

Date.	Stage of Ripeness.	Yield per acre.		Pounds per bu.	Wt. 100 berries.	Per cent kernel in berries.
		Lb. Straw.	Bu. Grain.			
1891. July 6.	Stems green, ½ leaves green, kernels mostly in milk	2887	64.4	34	2.31	69.8
" 11.	Kernels mostly in dough, some hard	2619	63.9	34.7	2.43	71.3
" 17.	Fully ripe	2179	59.4	34.5	2.46	71.2
....	Bound and shocked in ordinary manner	3180	63.1	34	2.46	70.8
....	Loose till dry, then bound and shocked	3179	56.5	34.7	2.38	71.7
....	Heads removed	1307	65.4	34.5	2.39	69.8
1892. July 16.	Stems green, ¼ leaves green, kernels mostly in dough, some in milk	1656	45.1	26.25	2.31	67.58
" 22.	Oats mostly hard, some in dough	1740	45.9	25.7	2.22	66.7
" 30.	Fully ripe	1284	33	25.4	2.25	66
....	Bound and shocked in ordinary manner	1892	45.5	26.5	2.27	67.6
....	Loose till dry, then bound and shocked	1770	42.8	25.9	2.27	66
....	Heads removed	1020	35.6	25.9	2.22	66.6

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UNIVERSITY OF ILLINOIS,

Agricultural Experiment Station.

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BULLETIN NO. 24.

VARIATIONS IN MILK.

This bulletin gives some results obtained from observations made with six cows during one period of lactation.

SUMMARY.

The butter fat was the most changeable constituent of the milk. The per cent of solids not fat was quite uniform. Both were higher in the last part of the period of lactation than in the first when the cows were fresh and the maximum quantity of milk was produced. This was especially true of the fat. As the activity of the milk glands gradually declines until the flow of milk ceases, the formation of the fat seems to hold out better than the other constituents of the milk.

Calculations of the total amount of milk and of butter fat were made from one, two, three, and four of the weights and tests of each month. The results so obtained were found to be in many cases 99, and in no case less than 90 per cent of the totals found by the daily weights and tests.

A gradual increase of the grain feed from 12 to 24 lb. a day per head and the change from stable to pasture feed each increased the yield of milk, but had very little if any effect on its quality.

OBJECT.

The object of this work was to get an exact record of the performance of different cows: To note what influence, if any, the changes in weather, season and feed actually had on these cows; their variation in live weight and in quantity of milk; the chemical composition of the milk in different parts of the period of lactation; how the composition was changed by any accidental or normal occurrence during the every day life of a cow for one year; the relative sensitiveness of different cows to the same cause or influence; to what extent the richness of milk was changed by a very large quantity of concentrated feed; and whether any or all the variations which might be noticed in the quantity and quality of the milk, applied to each of the cows included in this trial.

CONDITIONS AND METHODS.

The experiment began July 6, 1891, and ended Oct. 14, 1892. Some experience in this line of work was obtained with other cows during the preceding months of May and June.

The shortest milking period of any of the cows was 278, the longest 428, days.

An analysis of the weighed milk of each cow was made nearly every day. This included an estimation of the per cent of solids and of butter fat in the daily milk, and of casein and fat in a week's composite sample.

None of the six cows was a superior representative of its breed. They were average animals, such as are the actual producers of the greater part of the country's milk supply.

BREED AND AGE OF THE COWS.

No.	Name.	Breed.	Average weight.	Age, years, July, 1891.	Date of last calf.	No. of days milk was tested.
1	Jersey.....	Jersey	859	3	Sept.....	307
4	Jock......	Holstein....	1361	8	Jan......	278
5	Med......	Holstein....	1054	8	Nov.....	322
3	Grace	Shorthorn...	1022	3	June.....	428
16	Duchess ..	Shorthorn...	1108	8	August...	332
18	Duchess ..	Shorthorn...	1174	7	August .	342

The milking was done between the hours of five and six both night and morning. Each cow was not milked at exactly the same hour and minute every day, but the milking time was subject to such interruptions as are common in farm practice; hence there was observed no uniform difference in amount or richness between the night and morning milk of the cow whose milk of each milking was tested.

The cows were always tied up in the stable when milked. From May 1st to Nov. 1st they were either in the yard or pasture both day and night except at milking time. Beginning Nov. 1st the cows were stabled and only turned out into the yard a part of each day. This continued through the winter and spring until May 1st when pasture feeding began.

The weighing and testing of each cow's milk began about two weeks after calving.

A record was made of the pounds of milk given by each cow at each milking. The milk of cow No. 1 was sampled and tested after each milking.

A mixture of the morning and night milk of each of the other cows was tested every day. This gave a daily test of the milk from each of five cows, and of one cow's milk two tests each day.

The number of days in the year when the analyses of the different cows' milk were lost, is shown in the following table.

OMITTED ANALYSES.

Cow.	Number of determinations not made.		
	Of solids.	Of fat.	Of solids not fat.
No. 3	16	6	16
No. 4	7	3	8
No. 5	9	4	10
No. 16	11	2	11
No. 18	14	6	15
No. 1 a. m.	6	3	6
No. 1 p. m.	15	4	16

These missing tests were scattered throughout the year and were caused by some accident.

The cows were weighed every Monday at about 10 a. m.

The milking, weighing of the milk, and taking the samples for analysis were nearly all done by one man. He had some assistance at different times in the year.

The history of the cows' care and feed throughout the year was obtained from Mr. F. D. Gardner, assistant agriculturist of the Station.

The writer is responsible only for suggesting that an accurate record be kept, and, while the cows were stable-fed in the winter, that the grain should be gradually increased till the cows' daily ration was unusually large. From the figures thus obtained, the inferences in regard to the effect of the grain on the quantity and quality of the milk have been deduced as herein described.

All the samples of milk were brought to the laboratory and tested daily. Nearly all the analyses were made by Mr. Nelson, assistant chemist of the Station. This work amounted to something over 4,550 separate tests and analyses.

All the calculations necessary in making the tabular and other records contained in this bulletin have been made by two computers, in order to insure accuracy in the figures.

The tests made of each sample of milk included the per cent of butter fat, total solids, and solids not fat. The latter was calculated by difference.

A composite sample was collected from the milk of each cow. The per cent of casein and of butter fat was determined in each of these composite samples once a week, or after there was accumulated in them a mixture of samples taken from every milking for seven days. No preservative was added to these composite samples; but powdered lye was used to thin the sour milk when it was tested. This operation was performed as described by the writer in bulletin No. 16, p. 510, of this Station.

TESTS OF THE COMPOSITE SAMPLES DURING THE YEAR.

The butter fat tests of the composite samples were compared with the average of the tests made of the milk each day during the time the composite samples were collected. This comparison was made with the milk of each cow every week during the entire year. This work gave an opportunity to record observations on the use of the method in all seasons of the year, and with the milk of different breeds of cows. It also gave experience in the manipulation. We have not found it necessary to change materially the method as originally described. It can be and is successfully used by creameries in paying patrons on the "test plan," and our year's experience has taught us that with a fair amount of care it is practically accurate.

An agreement of the test of the composite sample with the average test was most difficult to obtain with very rich milk. With such milk. the composite sample test was often low. Milk of average composition (3.5 per cent fat) gave almost uniformly close agreement.

METHODS USED FOR ANALYZING THE MILK.

All the samples of milk were tested for butter fat by Dr. Babcock's method. The centrifugal machine used for making the separation of fat from the acid mixture was run by a one-horse power electric motor. [This is connected with the street electric railway of the city and makes a very convenient and useful laboratory power for grinding samples of feed. The speed is sufficiently uniform for testing milk.] During the first few months each sample of milk was tested for butter fat in duplicate ; later on the accuracy of each day's work was tested in the following way : A mixture was made of equal quantities of milk from all the samples tested at one time. A test of this mixed milk was compared with an average of the separate tests of the several samples used in making the mixture. If the two results agreed within one-tenth of one per cent, the work was not repeated. An examination was made of the correctness of the calibrations on each new test bottle used.

The per cent of total solids in each sample of milk was determined by drying in an oven surrounded by boiling water five grams of milk with about 25 grams of clean sea sand.

FEED OF THE COWS DURING THE YEAR.

The cows were at pasture from May 1st to Nov. 1st. The pasture was mostly blue grass with some timothy and white clover. The severe drought in the summer of 1891 made the feed rather short, and from July 28th to Oct. 1st each cow was given 15 lb. green corn-fodder at milking time, or 30 lb. a day. Oct. 1st to 26th corn-fodder, with the largest ears picked out, was thrown into the pasture and 10 lb. broken corn with 5 lb. hay was fed at the stable daily. Oct. 26th 1 lb. oil meal was added to this ration. Nov. 1st the pasture feeding stopped and stable feeding began with a daily feed per head of 20 lb. broken ear corn, 10 lb. hay, and 2 lb. oil meal. Nov. 11th began feeding ensilage, gradually increasing the quantity to all that the cows would eat and decreasing the daily feed of broken corn. This was continued with 2 lb. oil meal and 6 to 10 lb. hay daily until Dec. 25th. The Shorthorn cows ate the ensilage with a relish; the one Jersey was more dainty at first but gradually developed an appetite for it.

Dec. 25th the cows were divided into two lots. Lot 1 contained cows No. 1, 3, and 5; lot 2 No. 4, 16, and 18. The object of this separation was to increase gradually the grain feed of lot 1, and note the effect on the milk. The feed of lot 2 continued unchanged until the supply of ensilage was exhausted, Jan. 1, 1892. Jan. 1st to March 1st the daily feed per cow was 20 lb. broken corn (equal to 16 lb. shelled corn), and 12 lb. hay. After Feb. 16th No. 16 and 18 were fed oat straw instead of hay. March 1st to April 8th the grain feed was changed to 20 lb. daily of a mixture made of two parts corn and cob meal, 1 part wheat bran, and 1 part oil meal. April 8th to 14th this feed was decreased by taking out the bran. April 14th the daily feed was changed to 6 lb. oil meal and 22 lb. hay. April 30th the cows were turned out to a good pasture and no other feed was given. The changes in the daily feed per head of the cows in lot 1 after Dec. 25th, are given on page 162.

The records of the daily weights and tests of the milk of each cow are not given here; but from them the results shown in the following tables have been calculated. These tables give the live weight of the cow each month. This is an average of the weights made every week. The average weight of milk given per day for every month, and the largest and smallest amount of milk produced on any one day of the month. The daily average per month and extremes in per cent of solids, butter fat, and solids not fat found in the milk; the average of the per cents of casein found in the four composite samples of milk collected every month and the pounds of solids, butter fat, and solids not fat calculated from those weights and analyses.

The summary at the foot of each table shows the total weight of milk, butter fat, and solids not fat produced by each cow during the period of lactation, and the average per day for the whole time. Also the extreme variations observed on any day during the experiment.

The daily average per cents of solids and butter fat are found by dividing the total weight of solids and of fat by the total weight of milk, and multiplying by 100.

The length of the period of lactation, or the number of days the cow was milked during the year, is given at the top of the tables.

Cow No. 1 — Jersey.—This cow was milked 307 days. She was nearly 4 years old when this record began, and her live weight has varied during this test from 745 to 962 lb. She gave 5,043 lb. milk, which contained 254 lb. butter fat, equal to 305 lb. of butter.

WEIGHT OF MILK.

The most milk given at any one milking was 14 lb.; the least, 1 lb. The most milk given on any one day was 25.5 lb., and the average per day for the whole time was 16.4 lb.

The table shows that at some one milking during a month the

COW NO. 1, JERSEY. — THE DAILY AVERAGE AND

Weighing and Testing the milk began Oct. 6,

Month.	Live wt.	Pounds of milk.						Per cent of solids.						Per	
		p m.		a.m.		Daily.		p.m.		a.m.		Daily.		p.m.	
		Av.	Extr.	Av.	Extr.	Av.	Extr.	Av.	Extr.	Av.	Extr.	Av.	Extr.	Av.	Extr.
Oct. 6 to 31.....	851	10.6	12 8.5	12.3	14 10	22.9	25.5 18 5	14	14.8 13	13.7	14.7 12 4	13.8	14.6 13.1	4.8	6 4
November......	797	8.3	9 5 6	10.7	12 9.5	19	21 16.5	14	15.5 11.9	13.8	15 5 12.7	13.9	14 9 13	4.9	6.5 2.9
December	771	7.5	9 3 5	9.5	11.5 8	17	20.5 12.5	13.8	16.2 12.6	13.8	15 2 13	13.8	15 13.1	4.9	7.3 3.3
January	769	8 6	9.2 7.5	11.1	12.5 10	19.7	21.5 17.7	14.4	18.6 12.8	14.4	20.2 13.6	14.4	17.5 13.4	5	9.4 3.9
February	827	8.7	10.5 7.5	10 6	11.7 9.2	19 3	20 7 17	14.3	19.2 13 5	14.3	16 6 13.3	14 3	16.7 13.6	4.7	10.2 4.1
March	856	8.7	9.5 7.2	8.8	9 5 8	17.5	18.5 15 7	14.5	16 13.9	14 7	15.5 14.1	14 6	15.4 14.1	5	6.2 4.5
April	864	8.1	10.2 6.2	7.7	10 5.2	15.8	20.2 11.4	14.8	16.6 13.2	15.2	16.7 14.1	15	16.6 14	5.4	7.1 4
May............	890	8.4	9.7 7	7.6	9 5 6	16	18 13.5	15	17.1 13.6	15.3	16.9 13.8	15.1	16.7 14	5.1	5.9 4
June	927	6.4	7.2 5	6 3	7.5 5	12.8	14 2 10.7	15.3	16 8 14.3	15.5	16.9 14.2	15.4	16.3 14.5	5.6	7.1 4 6
July	947	3.8	5.7 1	4.2	7 1.5	8	12.2 3	16.8	20.1 13.7	16.7	22.4 14.2	16.8	19.4 14.8	6.3	9.7 3.3
Aug. 1 to 7	957	1 4	2 1	1 3	2 1	2 7	4 2	17.6	19.9 16.1	16.1	17.7 14 9	16.8	18.3 15.6	7.3	9.2 6.2
For the															
			12 1		14 1	16.4	25.5 2		20.1 11.9		22.4 12.4	14.4	19.4 13		10.2 2.9
Total		5043 9													

quantity of milk was considerably smaller or larger than usual; but the total milk of the different months was quite uniform. This cow was milked about 10 months, and during 9 months of this time her average daily milk decreased only from 23 to 13 lb., then in the last month she dried up very fast. This characteristic was not so marked with any of the other cows. She gave more milk at the morning than at the night milking for the first six months. During this time the morning milk was 1 to 4 lb. more than the night milk. There was no great difference either way in the amount of milk given at the two daily milkings in the last 4 months of her record. The night milk was 1 to 2 lb. greater during the first week the cow was at pasture; but for the remainder of the time very nearly the same quantity was given at both milkings. When a change in feed was made April 15th from 12 lb. corn and cob meal, 6 lb. oil meal, and 12 lb. hay to 6 lb. oil meal and 22 lb. hay, there was a sudden drop of 4 lb. in the amount of milk given, and this loss of milk continued till May 1st when pasture feeding began. Then the milk increased in quantity to about what it had been in the first part of April. There was a gradual decrease in the flow of milk from May

EXTREMES OBSERVED EACH MONTH FOR EACH MILKING.

1891, and continued to August 7, 1892—307 days.

cent of fat.				Per cent of solids not fat.						Per cent casein.			Solids, lb		Fat, lb.		S. not F.	
a.m.		Daily.		p.m.		a.m.		Daily.		a.m.	p.m.	Daily.	Daily.		Daily.		Daily.	
Av.	Extr.	Av.	Extr.	Av.	Extr.	Av.	Extr.	Av.	Extr.				Av.	Extr.	Av.	Extr.	Av.	Extr.
4 3	5.2 3.4	4.5	5.2 3.9	9.2	9.8 8.1	9.4	9.6 8.9	9.3	9.8 8.6	3 32	3.29	3.3	3.21	3.64 2.42	1.05	1.27 .73	2.16	2.45 1.69
4.4	6.1 3.3	4.6	5.6 4.1	9.1	9.6 8.4	9.4	9.7 8.5	9 2	9.5 8.7	3.13	3.39	3.26	2.63	3.03 2.22	.88	1.07 .73	1 75	1.96 1.49
4.5	5.8 3.8	4.7	5 9 3.9	8.9	9.7 8.4	9.3	10.6 7.8	9.1	9.5 8 7	2.98	3 10	3.04	2.36	2.92 1.72	.8	1 .59	1.56	1.94 1.13
4.8	11.2 4	4.9	8 2 4.2	9.4	9.7 8.4	9.6	10.5 9	9.5	10 8.9	3.38	3.49	3.43	2.82	3.48 2.47	.97	1.31 .81	1.85	2 1.55
4.5	6 8 3.6	4.6	7.4 4	9.6	9.9 9	9.8	10.3 9.4	9.7	10 9.3	3.68	3.68	3.68	2.75	3.22 2.4	.88	1.4 .76	1.87	2.1 1.6
4.8	5.8 4.4	4 9	5.5 4.6	9.5	9.8 9.2	9 9	10.4 9.5	9 7	10 9.3	3.69	3.70	3.69	2.57	2.94 2.4	.86	.98 .81	1.71	2.06 1.53
5.4	6.9 4.5	5.4	7 4.4	9.4	10 2 7.6	9.8	10 2 9.4	9.6	10.1 9.1	3.54	3.51	3.52	2 36	2.87 1.86	.84	1.04 .7	1.52	1.9 1 11
5 4	7.2 4	5.2	6.1 4.3	9 9	10.9 9.3	9.9	10.4 9.3	9.9	10.4 9.4	4.06	4.10	4.08	2.56	2.81 2	.84	1.05 .66	1.72	1.86 1.3
5.8	7.5 4.7	5.7	6.7 5	9.7	10.2 8.7	9.7	10.4 9.3	9.7	10.2 9.3	4.10	4.11	4.1	2	2.18 1.69	.72	.89 .6	1.28	1 38 1.01
6 3	12.3 4.2	6.3	9.2 4.3	10.5	11.7 9 9	10.4	10.9 9.4	10 4	10.8 9.9	4.6	4.39	4.5	1.38	1.99 .49	.49	.76 .16	.89	1.27 .33
5.5	6.7 4.6	6.4	7.5 5.6	10.3	10.9 9.9	10.6	11 9.9	10.4	10.8 10	5.3	3.88	4.59	.45	.49 .33	.17	.25 .12	.27	.43 .21
whole period.																		
	12.3 3 3	5	9.2 3.9		11.7 7 6		11 7.8	9.4	10 8 8.6				2.37	3.64 .33	.82	1.4 .12	1.55	2.45 .21
													729.41		253.89		475.52	

1st to 31st, of about 2½ lb. per day. It changed very little in June; but fell off very rapidly in July till the first of August, when the cow was dry.

As a rule the weights of the morning milk only varied one-fourth to one lb. from that of the preceding morning. The greatest variation of this kind was three and one-half lb., which happened only once. This was also true of the night milking. A comparison of the two milkings on any one day shows that while they were generally about the same in quantity, there were times when one would be high and the other low. The greatest difference of this kind was 6 lb. This occurred in the two milkings of the day the cow was bred.

SOLIDS OF THE MILK.

The average per cent of solids in the 614 samples of milk of this cow for the whole period of lactation was 14.4, the highest 22.4, and the lowest 11.9, a difference of 9.5. The difference between the extreme per cents of solids in the daily milk, however, was 6.4, and between the daily average per month 3, showing that, although the quality of the milk may take a sudden jump up or down at some particular milking, the change is not permanent.

There was only one sample of milk that showed 11.9 per cent solids; and but 9 out of the 614 that went below 13 per cent solids. A selection of the milks containing a high per cent of solids shows that four samples reached 20 per cent solids, but only one was 22 per cent, and that 26 samples were over 17 per cent of solids.

When the cow was fresh and gave the most milk, it contained the minimum amount of solids. The table shows that the milk gradually increased in richness of solids as the period of lactation advanced, until it reached the maximum, when the flow of milk was at its minimum, and the cow drying up. The per cent of solids went as low as 14.9 at one milking during the last week of the lactation period, and up to 19.9 a difference of 5; while in the first week there was a variation of only 2.3. This indicates that the milk of this cow was subject to quite extreme changes in quality, especially when the quantity was small. A comparison of the per cent of solids found in the morning milkings of each month, shows that with the exception of 3 months there was a difference of 1.8 to 3.8 per cent between the extremes. The greater differences observed in the 3 months were 5.6, 5.8, and 6.4. The variations of 5.6 and 5.8 per cent occurred six days apart, at the time when the heavy grain ration was begun. The difference of 6.4, between the highest and lowest of solids, was observed in the milk of the last month, when the cow was drying up. The night milkings showed similar variations. A study of the variations that occurred in the daily milk, or the sum of the analyses of the morning and night milk divided by two, shows a much smaller difference between extremes. When the heavy grain feeding was begun, there was a difference of 4.1 per cent solids between the extremes of that month, and of 4.6 in the last month of the period of lactation. With the exception of these two months there was a difference of only 1.3 to 3.1 between the highest and lowest daily per cent of solids every month. The variations occurred quite as often above as below the average, making the quality of the milk from one month to another about the same, except that it gradually increased in richness up to the end of the period of lactation. This is illustrated by the figures of the foregoing table and the diagram after page 152.

BUTTER FAT IN THE MILK.

The average per cent of fat in the milk of this cow was 5; the highest 12.3; the lowest 2.9 — a difference of 9.4. As has been stated before, the difference between the highest and lowest per cent of solids in the milk was 9.5, indicating that the fat is naturally the variable quantity in the solid matter of milk. The lowest per cent of fat, 2.9, was found in only one sample of milk, that of the morning of November 28th. Only 5 out of the 614 samples contained less than 3.5 per cent fat. The samples of milk which contained the most fat were nearly all from the latter part of the period of lactation, only one sample reached 12 per cent fat, four were 10 per cent or over, and 25 were 7 per cent or over.

The table and the diagram show that during the first six months after calving the milk contained between 4 and 5 per cent of butter fat; after that time the average per cent was between 5 and 6. The difference between the highest and lowest per cent of fat in the morning milkings of the different months varied from 1.4 to 3.2, with the exception of two months, when the difference was 7.2 and 8.1. These were the same months when the greatest variation in solids was noticed. The night milk showed the same peculiarities, while, excepting these two months, the daily milk of each month showed a difference of only from .9 to 3 between the extreme per cents of fat observed in any one month. During the last two weeks of the period of lactation, when the cow gave only 2 to 5 lb. of milk daily, the per cent of fat was all the way from 6 to 9.4 and varied greatly from day to day. There were also several milkings at different times in the period of lactation when the milk contained 7, 9, 10 and 11 per cent of fat. At such times the amount of milk was neither very much above or below the average for that time. The per cent of fat in the morning milk was not greater or less than in the night milk for any great number of days. During short periods of 3 to 10 days in the year there would be a difference in the fat contents of the morning milk as compared with the night milk for the same time, but it soon changed and neither one was higher or lower than the other for more than 10 days at a time.

SOLIDS NOT FAT.

These include the casein, milk sugar, and mineral substances of the milk. The average quantity contained in the milk of this cow was 9.4 per cent. The lowest per cent found in any sample of milk during the year was 7.6; the highest, 11.7—a difference of 4.1. Only 3 samples of this cow's milk went below 8 per cent of solids not fat and 24 above 10.5 per cent. The diagram and the figures in the table show that this constituent of the milk did not make such extreme variations as were observed in the butter fat. The per cent of solids not fat in the milk was very uniform throughout the whole period of lactation. It varied from 9 to 9.5 in the first three months, gradually rising to 9.5 to 10 during the next six months and was 10 to 10.5 the last month of the milking period. The per cent of solids not fat was generally .2 to .5 higher in the morning than in the night milk, except during the last two months of the period of lactation when there was no uniform difference either way.

Excepting a few times when analyses were lost, the milk of this cow was tested 307 days. As there were two milkings each day this made 614 samples. The average of all tests showed the milk to have the following composition: solids, 14.4; fat, 5; solids not fat, 9.4 per cent. The highest and lowest percentages found in these samples were, solids, 11.9 to 22.4; fat, 2.9 to 12.3; solids not fat, 7.6 to 11.7.

The following table has been constructed from the record of all these samples to show that the extreme per cents were exceptional and that most of the milk was of a uniform quality. The table shows how many of the 614 samples of this one cow's milk were above 15 per cent and below 13.5 per cent solids; above 5.5 and below 4 per cent fat; above 10 and below 9 per cent solids not fat.

NUMBER OF SAMPLES OUT OF 614 IN WHICH PERCENTAGES OF SOLIDS, FAT, AND SOLIDS NOT FAT WERE ABOVE OR BELOW CERTAIN STANDARDS.

Per cent solids.	Per cent solids over 15 and under 13.5.			Per cent fat.	Per cent fat over 5.5 and under 4.			Per cent solids not fat.	Per cent. solids not fat over 10 and under 9.		
	a.m.	p.m.	*Daily av.		a.m.	p.m.	*Daily av.		a.m.	p.m.	*Daily av.
15–15.5	35	31	28	5.5–6	29	37	35	10–10.5	37	27	25
15.5–16	31	10	27	6–6.5	21	26	23	10.5–11	12	10	11
16–17	26	19	22	6.5–7.5	16	11	13	11–11.7	....	2	......
17–18	6	4	9	7.5–9	3	9	4				
18–20	2	11	3	10–12	3	1	......				
20	3	1	......		....	....	......				
Total.......	103	76	89		72	84	75		49	39	36
†Percentage of the whole.	30	25	29		23	27	24		16	12	11
13.5-13	19	9	14	4-3.5	13	2	2	9–8.5	3	30	11
13–12.5	4	4	.....	3.5–3	2	2	......	8.5–8	....	5	......
								8–7.5	1	2	......
Total.......	23	13	14		15	4	2		4	37	11
†Percentage of the whole.	7	4	4		5	1	......		1	12	4

*The daily average means here the per cent found each day by dividing by two the sum of the per cents found in the morning and night milk of each day.

†307 is taken for the whole number of samples in calculating this percentage.

A study of this table shows that the quality of the morning and night milk varied about the same. From one-fourth to one-third of all the samples contained over 15 per cent solids, but most of these were between 15 and 17; only very few went over 17 per cent, while 4 to 7 per cent of the whole number of samples went under 13.5 per cent, and a still less number under 13 per cent solids.

About one-fourth of all the samples had over 5.5, a very few were above 7, and only four had 10 to 12 per cent fat. There were only four samples below 3.5 per cent, and 17 out of the 614, between 3.5 to 4 per cent fat.

The limits of variation in the solids not fat are still narrower. Only two samples had over 11 per cent, and 3 under 8 per cent.

Cow No. 3—Shorthorn.—The weighing and testing of this cow's milk was made every day for fourteen months. This unusually long period of lactation was due to her failure to get with calf. It makes her record all the more useful, as evidence of what the quality of milk is under these conditions, which occur more or less frequently among cows. She was four years old, and her live weight varied from 888 to 1,160 lb.

WEIGHT OF MILK.

The milk of this cow was weighed every milking, but the analyses were made on one daily sample, which was a mixture of equal parts of the morning and night milk. The total quantity of milk produced was 6,193 lb. This contained 228 lb. fat, equal to 274 lb. butter. The most milk given on any day was 26.5 lb. in July, the first

COW NO. 3, SHORTHORN.—THE DAILY AVERAGE AND EXTREMES OBSERVED DURING EACH MONTH.

Weighing and Testing of Milk began July 6, 1891, and continued to September 4, 1892—428 days.

1891-92.	Live Wt.	Pounds.		Per cent.							Pounds.				
		Milk.		Solids.		Butter fat.		Solids not fat.		Casein	Solids		Butter fat.		Not fat.
		Ave.	Extr.	Ave.	Extr.	Ave.	Extr.	Ave.	Extr.	Ave.	Ave.	Extr.	Ave.	Extr.	Ave.
July 6-31	993	24	26.5 20.5	12.2	13.4 11.7	3.7	4.4 2.7	8.5	10.3 8.5	3.23	2.93	3.56 2.45	.89	1.17 .62	2.04
August..	974	22.5	25 21	11.9	12.5 11.4	3.2	3.9 2.7	8.7	9 8	3.03	2.68	3.18 2.32	.72	.97 .57	1.96
Sept.....	957	17.8	22.5 12.5	12.1	13.3 11.4	3.3	4.2 2.8	8.8	9.1 8.4	3.05	2.15	2.78 1.45	.59	.85 .35	1.56
Oct.	958	13.9	16.5 11	12.9	14.5 12	3.7	4.4 2.9	9.2	10.4 8.5	3.33	1.79	2.09 1.3	.51	.66 .38	1.28
Nov.....	920	11.9	14 8.5	12.9	14.1 12	3.7	5 2.5	9.2	10.3 8.8	3.26	1.53	1.9 1.1	.44	.67 .29	1.09
Dec.....	920	12.1	16 10	12.8	14 10.8	3.8	4.9 3	9	9.6 7.2	2.92	1.55	2.11 1.33	.46	.6 .34	1.09
Jan.	927	16	17.7 14	13.1	14.2 12.5	3.7	4.6 2.7	9.4	10.2 9	3.34	2.10	2.41 1.84	.58	.76 .44	1.52
Feb. ...	1035	16.1	17.7 13.5	13.2	14.9 12.3	3.6	5.8 3.2	9.6	10 8.6	3.47	2.12	2.32 1.75	.58	84 .51	1.54
March..	1047	14.3	16 12.5	13.5	14.4 12.9	3.8	4.7 3.4	9,7	10.1 9.3	3.52	1.93	2.12 1.75	.54	.61 .5	1.39
April....	1054	13.8	16.5 11.5	13.5	15.1 12.7	4	5.8 3	9.5	10.5 9.1	3.49	1.86	2.13 1.59	.55	.72 .46	1.31
May....	1079	14.5	17.2 10	13.3	14.3 12.8	3.8	4.6 3.4	9.5	9.9 8.9	3.89	1.93	2.31 1.39	.55	.7 .44	1.38
June....	1105	12.1	14 9.2	13.1	17.8 12.1	3.9	4.6 3.2	9.2	9.9 8.3	3.42	1.58	2 31 1.11	.47	.57 .35	1.11
Juy....	1118	9.3	12.2 6	13.3	16.2 12	4.2	6.2 2.8	9.1	11.1 7.4	3.8	1.24	1.62 .82	.39	.6 .27	.85
August..	1130	6.4	9.7 3.5	13.7	17 12.4	4.7	7.9 2.9	9	11.3 8.2	3.87	.87	1.4 .5	.3	.5 .16	.57
	For the whole period.														
		14.4	26.5 3.5	12.8	17.8 10.8	3.7	7.9 2.5	9.2	11.3 7.2		1.85	3.56 .5	.53	1.17 .16	1.32
Totals ..		6193.3									794.37		227.8		566.57

month after calving. The preceding table shows that the milk decreased in quantity but little in August, the second month of the lactation period, but gradually diminished in the third and fourth months, till the fifth month, November, when she gave only about 12 pounds of milk daily. The quantity increased during the winter months of stable feeding, on a liberal grain ration, and it was not till the next July that the milk flow was so small as it had been in November. In August and September, the thirteenth and fourteenth months, the flow of milk diminished till the cow "went dry."

The average amount of milk given per day, for the whole period of lactation, was 14.4 lb., and for nine months of this time the daily average per month varied very little from this figure; for one month it was 2.5 lb. more, and another month 1.7 lb. less.

The minimum amount milk given in one day was 3.5 lb., and there were several days at the end of the milking period when she gave only four pounds.

No great variation was observed in the weight of milk produced from day to day in any month. There was a difference of 7 and 10 lb. between the highest and lowest daily milk of two months; but in the other twelve months this difference between extremes was from 3.5 to 6 lb. The daily milk was increased 6 lb. by a heavy grain ration in winter, and again by change from stable feeding to pasture.

Solids of the Milk.

The average per cent of solids in the 428 samples of this cow's milk was 12.8; highest, 17.8; lowest, 10.8—a difference of 7. The table shows that between the daily averages per month there was only a difference of 1.8 per cent of solids. There was only one sample that had 17.8 per cent of solids, and two that went as low as 10.8 per cent. Thirty-four samples were below 12 per cent (11.9 to 11.4); 28, above 14 per cent; but of these latter only 7 went above 15 per cent. There was a slight increase in the amount of solids in the milk from the first to the last part of the milking period; but the table shows that the per cent of solids was quite uniform through all the changes of feed and season in the 14 months of the trial.

Butter Fat in the Milk.

The average per cent was 3.7 in the milk of this cow; highest, 7.9; lowest, 2.5 per cent — a difference of 5.4. Only one sample went as low as 2.5 per cent, and 17 samples gave less than 3 per cent (2.7 to 2.9). One sample only reached 7.9 per cent; three, 6 to 7 per cent; sixteen, 5 to 6 per cent, and seventeen 4.5 to 5 per cent — making out of a total of 428 samples of milk from this cow 56 that were outside the limits of 3 to 4.5 per cent fat. As a rule the minimum per cent of fat was found in the milk when the cow was fresh, and gave the largest quantity, and the maximum per cent of fat was during the last part of the milking period. The table shows, however, that there were days in the last month of the period of lactation when the milk contained only 2.9 per cent fat.

SOLIDS NOT FAT.

The average per cent was 9.2; highest, 11.3; lowest, 7.2 per cent. With the exception of these two extremes, no sample went below 8 per cent, or above 10.5 per cent. There were only 10 other samples below 8.5 per cent, and seven above 10 per cent, making 410 out of the 428 samples that contained between 8.5 and 10 per cent of solids not fat. This illustrates what was also found true with cow No. 1, that the per cent of solids not fat is very uniform, and that the fat is the variable quantity in the milk solids.

The milk of this cow was quite uniform in quality throughout the whole milking period, and the sudden changes frequently observed in the milk of cow No. 1 did not occur.

Cows No. 16 and 18—Shorthorns, ages 8 and 7 years.—The tables show that these two cows were very much alike in the quantity

COW NO. 16, SHORTHORN.—THE DAILY AVERAGE AND EXTREMES OBSERVED DURING EACH MONTH.

Weighing and Testing of Milk began August 31, 1891, and continued to July 27, 1892—332 days.

	Live Wt.	Pounds.		Per cent.							Pounds.					
		Milk.		Solids.		Butter fat.		Solids not fat.		Casein, av.	Solids.		Butter fat.		Not fat.	
		Av.	Extr.	Av.	Extr.	Av.	Extr.	Av.	Extr		Av.	Extr.	Av.	Extr.	Av.	Extr.
Sept..	1127	22.7	37.5 19	12.5	14 11.1	3.5	4.6 2.4	9	10.7 8.5	3.22	2.83	4.17 2.22	.79	1.03 .5	2.04	3.27 1.67
Oct....	1104	15.5	21.5 8	13.2	14.5 12.3	3.9	4.9 3.2	9.3	9.7 8.9	3.46	2.04	2.71 .84	.6	.8 .42	1.44	1.97 .32
Nov...	1068	12.9	16 9	13.5	15.8 12.5	4	5.8 3.2	9.5	10.3 8.9	3.65	1.74	2.15 1.19	.52	.85 .35	1.22	1.51 .84
Dec...	1041	11.9	13.5 11	13.3	14.5 12.2	3.9	5.2 3.4	9.4	10 8.8	3.33	1.58	1.88 1.43	.46	.67 .38	1.12	1.25 .97
Jan...	1036	12.2	14 11	13.2	13.9 12.6	3.9	4.5 3 4	9.3	9.8 9	3.34	1.61	1.84 1.44	.47	.56 .41	1.14	1.28 1
Feb .	1057	10.3	13.5 7.5	13.5	14.4 12.5	3.9	5.4 3.3	9.6	9.6 8.9	3.2	1 39	1.77 .96	.4	.62 .25	.99	1.22 .71
March	1063	10.1	11.5 8	13.4	14.3 12.1	3.9	4.7 3.1	9.5	9.8 8.9	3.6	1.35	1.53 1.07	.39	.47 .33	.96	1.15 .74
April .	1095	9.3	13.2 6.2	13.9	15.6 12.5	4.1	5.3 2.9	9.8	10.6 9.1	3.63	1.29	1.69 .93	.38	.6 .28	.91	1.2 .64
May..	1176	5.9	8.5 2.2	14	19.4 11	4.1	9.2 1.8	9.9	10.2 9.2	4.2	.83	1.36 .34	.24	.36 .09	.59	.8 .16
June..	1195	6	7.5 5	13.4	14.6 12.5	3.9	4.6 3.5	9.5	10.6 8.9	4.05	.8	1.09 .67	.23	.34 .19	.57	.75 .47
July ..	1236	6.1	9 5	13.7	14.7 11.7	4	4.8 1 9	9.7	10 3 8.9	4.45	.83	1.02 .54	.24	.36 .13	.59	.8 .18
	For the whole period.															
		11.2	37.5 2.2	13.3	19.4 11	3.9	9.2 1.8	9.4	10.7 8.5		1.49	4.17 .34	.44	1.03 .09	1.05	3.27 16
Total.	...	3738.2		....							495.62		145.8		349.82	

and quality of their milk; but quite different from the other four cows. They each gave something over 3,000 lb. of milk, and it contained, No. 16, 146 lb., and No. 18, 115 lb., butter fat. Previously to this year they had been used for raising calves, and consequently had been milked very little. This undoubtedly accounts for this poor record. The tables show that there was a great variation in the daily weight of milk given each month. This was particularly true when the cows were fresh in milk. During the first month after calving No. 16 varied from 25 to 10.5 lb., and No. 18 from 37.5 to 19 lb. milk per day. There were very unexcusable deviations in the milk all through the period of lactation. This was probably caused by their lack of training as milch cows. They often refused to give down their milk. The analyses show that their milk was of average quality. The per cents of solids and of fats varied more than in

COW NO. 18, SHORTHORN.—THE DAILY AVERAGE AND EXTREMES OBSERVED DURING EACH MONTH.

Weighing and testing of milk began August 31, 1891, and continued to August 7, 1892—342 days.

Month.	Live Wt.	Pounds.		Per cent.							Pounds.					
		Milk.		Solids.		Butter fat.		Solids not fat.		Casein, av.	Solids.		Butter fat.		Not fat.	
		Av.	Extr.	Av.	Extr.	Av.	Extr.	Av.	Extr.		Av.	Extr.	Av.	Extr.	Av,	Extr.
Sept..	1140	19.1	25 10.5	12.2	14.8 11.2	3.3	6.4 2.2	8.9	9.3 8.4	3.19	2.33	3.27 1.25	.63	1.41 .31	1.7	2.37 .94
Oct...	1123	13.3	17 8.5	12.8	14.7 10.2	3.6	5 2.6	9.2	10.8 8.7	3.45	1.7	2.27 1.1	.48	.66 .34	1.22	1.78 .76
Nov..	1114	10.5	16 6.5	13.1	15 12.1	3.8	5.4 2.7	9.3	10 8.6	3.43	1.37	2.15 .85	.40	.65 .23	.97	1.5 .62
Dec...	1131	9.2	13 4	13	15 11.8	3.7	5.5 2.6	9.3	10.8 8.2	3.15	1.19	1.78 .52	.34	.51 .14	.85	1.27 .38
Jan...	1130	9.1	11 7.7	13.5	14.5 12.6	4	4.8 3.3	9.5	10.1 9	3.34	1.23	1.47 1.06	.36	.45 .28	.87	1.05 .75
Feb...	1138	8.2	10 6.5	13.2	14.6 12.4	3.6	4.9 3	9.6	10 8.9	3.2	1.08	1.35 .85	.29	.39 .25	.79	.96 .59
March	1144	7.1	9 5.7	13.6	14.8 11.8	4	5.2 3.4	9.6	9.9 8.4	3.45	.96	1.26 .8	.28	.43 .24	.68	.85 .53
April.	1168	6.2	8.2 4.2	14.1	16.5 12.3	4.3	6.2 2.7	9.8	10.5 9.2	3.63	.87	1.09 .61	.26	.46 .14	.61	.79 .42
May..	1224	5.9	7.2 3	13.6	17.8 11.8	4	8.1 2.8	9.6	10 8.4	4.12	.8	1.06 .37	.24	.42 .1	.56	.78 .27
June..	1243	6.8	8.2 4.5	13	15.1 12.1	3.8	5.4 2.7	9.2	9.8 8.4	3.65	.89	1.05 .54	.26	.36 .14	.63	.77 .4
July..	1270	3.8	6 1.2	13.5	15.3 12.2	4	5.6 2.8	9.5	11 8	4.19	.51	.86 .15	.15	.36 .04	.36	.6 .11
	For the whole period.															
		8.9	25 1.2	13.1	17.8 10.2	3.7	8.1 2.2	9.4	11 8		1.17	3.27 .15	.33	1.41 .04	.84	2.37 .11
Total.	....	3069.3		....							399.8		115.3		284.5	

the milk of any of the other cows, except No. 1, whose milk was much richer.

The per cent of solids not fat in the milk of these cows, as in that of the others, was the most constant constituent of the milk, and the per cent of fat was the most variable.

Unlike the other cows' milk, that of these two did not increase in richness very much in the last part of the period of lactation. The erratic nature of these cows is illustrated by comparing the extremes observed in the first and last month of their milking period.

COWS NO. 16 AND NO. 18.—EXTREMES IN MILK PRODUCT OF FIRST AND LAST MONTHS.

Cow No. 16. First month.	Daily milk, lb.	Per cent		Cow No. 18. First month.	Daily milk, lb.	Per cent	
		Solids	Fat.			Solids.	Fat.
Highest........	37.5	14	4.6	Highest........	25	14.8	6.4
Lowest........	19	11.1	2.4	Lowest.........	10.5	11 2	2.2
Last month.				Last month.			
Highest........	9	14.7	4.8	Highest........	6	15.3	5 6
Lowest.........	5	11.7	1.9	Lowest.........	1.2	12.2	2.8

The uncommon features illustrated in this table are several: First, that there should be such a variation in the daily weight and composition of milk in the first month of the milking period; second, that the per cent of fat should be so high in the first month when the average of the cow's milk was 3.5; third, that the quality of the milk in the two months should be so nearly the same; and fourth, that milk of such a low per cent of solids and fat should be produced in the last month of the period of lactation.

Several other very striking illustrations of great variations are shown in the following table:

COWS NO. 16 and 18.—SOME EXTREME VARIATIONS IN MILK PRODUCT.

Cow No. 16.	Milk, lb.	Per cent.			Cow No. 18.	Milk, lb.	Per cent.		
		Solids.	Fat.	Solids not fat			Solids.	Fat.	Solids not fat
Oct. 9	18.5	13.4	3.9	9.5	Sept. 17	17.5	11.4	2.7	8 7
10	6.5	12.9	3.6	9.3	18	10.5	11 9	3	8.9
11	8	12.4	3.2	9.2	19	22	14.8	6.4	8.4
12	16.5	12 4	3.4	9	20	16.5	12.3	3.6	8.7
13	17.5	13.3	4	9.3	21	19 5	11 7	2.8	8.9
April 30	8	14.2	4.2	10	April 30	6.5	13.7	4.2	9.5
May 1	8.5	13.7	4.3	9.4	May 1	5.7	13.2	3.9	9.3
2	4.5	12	2.6	9 4	2	4.2	11.8	3.4	8.4
3	5	11	1.8	9.2	3	5	12.3	2.8	9 5
4	4.2	12	2.5	9.5	4	3	12.6	3.2	9.4
5	3.2	12.7	3	9.7	5	3.5	13	3.6	9.4
6	7	19.4	9 2	10.2	6	5.2	17.8	8.1	9.7
7	2.2	15.4	5 6	9.8	7	3	13.6	4	9 6
8	6 5	14.5	4.6	9.9	8	4.5	13.1	3.4	9.7
9	6.5	14	4.2	9.8	9	7	14.2	4.5	9.7
10	6	14.3	4.4	9.9	10	5.5	13 6	3.8	9.8

Cow No. 16 had been giving from 16 to 18 lb. milk daily, and the sudden change to 6.5 and 8 lb. Oct. 10th and 11th, and then a return to her usual quantity without much change in the quality of the milk is a variation that the other cows did not show, except No. 18 which made nearly an equal variation in September. A sudden change from 10.5 to 22 lb. milk was recorded on Sept. 18th and 19th ; the quality of the milk changed also from 11.9 to 14.8 per cent solids and from 3 to 6.4 per cent fat. Afterward the amount and richness of the milk was about what it had been before this break and continued quite uniform.

When the cows were first turned out to pasture they were not fed grain at milking time, as had been the custom previously. The feed in the pasture was ample, and, with the exception of these two cows, the flow of milk suddenly increased in quantity. The lower part of the table shows how these two cows were affected by the change to pasture and absence of grain when milked. They gave less milk of poorer quality than before and continued to do so for a week with the exception of one day, May 6th, when both amount and richness, especially the latter, were very high. May 9th, 3 lb. bran was fed at milking time. This was continued and the milk returned to its usual record before pasture feeding began.

The complete record of the milk given by cow No. 16 during the whole period of lactation shows that the average composition of the 332 samples was solids, 13.3 per cent; fat, 3.9 per cent; solids not fat, 9.4 per cent. The per cent of solids was less than 12 in 12 samples, and only one went as low as 11 per cent. It was more than 14.5 in 20 samples and only once as high as 16 and 19.4 per cent. The per cent of fat was less than 3 in 12 samples and was less than 2.4 only twice. Eleven samples were over 5 and only one (9.2) was above 6 per cent fat. The per cent of solids not fat did not go below 8.5. It was above 10 per cent in 18 samples.

The average composition of the 342 samples of milk from cow No. 18 was solids 13.1; fat, 3.7; solids not fat, 9.4. Eleven samples went under 12 per cent, the lowest one was 10.2 per cent. 22 samples were over 14.5 per cent solids and only one (17.8) above 16.5 per cent. One sample contained 2 per cent fat, and 25 were between 2 and 3 per cent. One sample was above 6.4 per cent and 16 between 5 and 6.4 per cent. Eight samples contained less than 8.5 per cent, and 12 went over 10 per cent solids not fat.

Cows No. 4 and 5 Holstein. Each 9 years old March, 1892. The record of these two cows shows them to be producers of more but thinner milk than the other cows. No. 4 was a large cow and varied in weight from 1258 to 1457 lb. in the 278 days of her milking period. No. 5 varied less in live weight during her period of lactation than did any other cow, 1005 to 1094 lb. The record shows that the quantity of milk given by both cows did not decrease very much until the last two months. The most milk given on any one day by No. 4 was 37 lb.; No.

5, 34 lb. The daily average for the year was for No. 4, 21.7; No. 5, 22 lb. This is a larger quantity per day than any of the other cows gave. There were no sudden changes in the weights of the daily milk of No. 5, but No. 4 often varied 6 to 10 lb. from what she gave the day previous. This happened during pasture feeding but not before. The average per cent of solids in the milk of No. 4 was 11.9 and of fat, 3.3. This is lower than the standard for unadulterated milk which some state laws require. The table shows for the same cow that the per cent of both solids and fat increased in the last part of the period of lactation and in the last two months was over 12 per cent solids and 3.5 per cent fat. During the whole milking period of 278 days the per cent of solids went over 13 per cent on 29 days, but was over 14.7 only 3 days. It was 11 to 10 per cent 16 days and less than 10 only one day. The per cent fat went above 4.5 on 25 days, but was over 6 per cent only once. It was less than 3 per cent on 72 days but under 2 per cent only 4 days.

The per cent solids not fat was over 9 on 24 days and reached 10.9 but once. It was less than 8 per cent eight times, going once as low as 7.2 per cent.

COW NO. 4, HOLSTEIN.—THE DAILY AVERAGE AND EXTREMES OBSERVED DURING EACH MONTH.

Weighing and testing of milk began Jan. 13, 1892, and continued to Oct. 16, 1892—278 days.

Month.	Live Wt.	Pounds.		Per cent.							Pounds.					
		Milk.		Solids.		Butter fat.		Solids not fat.		Casein, av.	Solids.		Butter fat.		Not fat.	
		Av.	Extr.	Av.	Extr.	Av.	Extr.	Av.	Extr.		Av.	Extr.	Av.	Extr.	Av.	Extr.
Jan...	....	29.6	34.7 27.5	11.9	12.6 10.8	2.9	3.6 2.5	9	9.2 8.3	2.93	3.53	4 3.11	.88	1.04 .68	2.65	2.84 2.4
Feb ..	1329	26.3	32.7 18	11.1	11.8 10.6	2.8	4.1 2.4	8.3	9 7.2	2.64	2.93	3 36 1.9	.75	1.04 .43	2.18	2 56 1.47
March	1303	26.1	29.5 20.7	11.8	12.7 11.1	3.2	4.2 2.8	8.7	8.8 8.2	2.81	3.08	3.55 2.31	.85	1.11 .62	2.23	2 65 1.69
April .	1286	26.5	33.5 20.2	11.9	13.2 10.4	3.2	4.5 2.7	8.7	9.7 7.8	2.85	3.16	4 2.5	.87	1.09 .63	2.29	3.32 1.59
May..	1379	29.7	37 20.7	12	15 10.6	3.1	4.7 2.2	8.9	10.9 8.2	3.14	3.57	5.09 2.46	.91	1.43 .63	2.66	3.57 1.80
June..	1448	24.7	35.2 13.2	11.9	16 10.1	3.4	6.6 1.6	8.5	9.4 7.8	3.22	2.96	4.29 1.36	.85	1.6 .25	2.11	2.99 .91
July ..	1417	18.6	27.7 10	12.1	14.1 10.6	3.6	5.6 2.4	8.5	9.1 7.9	3.45	2.25	3.54 1.21	.67	1.3 .32	1.58	2.42 .81
Aug ..	1370	14.6	20.2 9	12	14.2 10.7	3.7	5.4 2.2	8.3	8.8 7.9	3.63	1.76	2.61 1.2	54	.96 .31	1.22	1.75 .74
Sept..	1471	10.8	17 4.7	12.4	14.7 9.1	3.8	5.8 1.5	8.6	9.7 7.6	3.69	1.34	2.09 .64	.41	.78 .23	.93	1.47 .41
Oct...	1493	5.1	7.7 1.7	13.3	17.1 10.5	4	5.3 1.7	9.3	10.6 8.4	4.11	.68	1.08 .29	.2	.33 .1	.48	.75 .26
	For the whole period.															
		21.7	37 1.7	11.9	17.1 9.1	3.3	6.6 1.5	8.6	10.9 7.2		2.58	4.29 .29	.71	1.6 .1		
Totals		6.032									718.28		198.2			

COW NO. 5 HOLSTEIN.—THE DAILY AVERAGE AND EXTREMES OBSERVED DURING EACH MONTH.

Weighing and testing of milk began Nov. 30, 1891, and continued to October 16, 1892—322 days.

Month.	Live Wt.	Pounds.		Per cent.							Pounds.					
		Milk.		Solids.		Butter fat.		Solids not fat.		Casein, av.	Solids.		Butter fat.		Not fat.	
		Av.	Extr.	Av.	Extr.	Av.	Extr.	Av.	Extr.		Av.	Extr.	Av.	Extr.	Av.	Extr.
Dec . .	1048	25.6	30 22.7	12.2	13.5 11.4	3.6	4.3 2.8	8.6	10.7 8.2	2.75	3.13	3.63 2.75	.92	1.11 .7	2.21	2.67 1.91
Jan . . .	1035	30	33.5 27.7	12.7	14.6 12	3.9	6.2 3	8.8	9.2 8.4	2.86	3.83	4.42 2.66	1.17	1.87 .97	2.86	3.01 1.36
Feb . .	1082	30.4	34 27.2	12.5	13.7 11.8	3.5	4.8 3	9	9.3 8.6	2.9	3.8	4.52 3.52	1.08	1.58 .94	2.72	3.04 2.44
March	1080	26.9	30.2 24.5	12.5	13.7 11	3.6	4.4 2.6	8.9	9.5 8.5	2.88	3.37	3.73 2.91	.98	1.33 .69	2.39	3.55 2.19
April .	1049	23	29.7 17.2	12.6	16 11.7	3.5	4.5 2.9	9.1	11.5 8.7	3.01	2.91	3.47 2.27	.81	.99 .67	2.1	2.61 1.55
May . .	1043	22.5	29.7 21	12.6	13.7 11.6	3.4	4.7 2.8	9.2	9.4 8.3	3.39	2.84	3.83 2.49	.78	1.13 .6	2.06	2.7 1.82
June . .	1064	20.1	24.7 16.2	12.1	13.2 11.5	3.5	4.3 2.9	8.6	9.5 8.1	3.08	2.45	3.01 1.92	.72	.89 .61	1.73	2.12 1.02
July . .	1067	20.1	23.5 18.2	12.1	12.7 11.6	3.6	3.9 3.3	8.5	9 7.8	3.05	2.45	2.89 2.13	.73	1.18 .43	1.72	2.05 1.36
Aug . .	1036	16.5	20.7 12.5	12.5	13.6 12.2	3.8	4.8 3.3	8.7	9.3 7.9	3.1	2.07	3.1 1.64	.64	.83 .53	1.43	2.27 1.04
Sept . .	1082	11.7	15.7 8.2	13.3	15.3 11.8	4.3	6.2 3.1	9	9.9 8.3	3.54	1.56	2 1.14	.51	.75 .34	1.05	1.41 .79
Oct . . .	1122	6.7	9.5 3	14	17.8 12.1	4.1	8 2.2	9.9	11.6 9.2	4.23	.94	1.3 .79	.28	.48 .13	.66	.9 .29
	For the whole period.															
		22	34 3	12.4	17.8 11	3.7	8 2.2	8.7	11.6 7.8		2.74	4.52 .79	.81	1.87 .13		
Totals		7,106.4									885.16		261.87			

The following table illustrates several of the sudden changes that occurred in the milk of this cow, both in amount and richness.

COW NO 4. SOME VARIATIONS IN MILK PRODUCT.

	Milk, lb.	Per cent.				Milk, lb.	Per cent.		
		Solids	Fat.	Solids not fat.			Solids.	Fat.	Solids not fat.
May 9	27	11.8	3	8.8	June 16	25	11.4	3	8.4
10	24.7	12	3	9	17	16	10.1	1.6	8.5
11	34	15	4.2	10.8	18	15.7	11.3	3.3	8
12	28.7	11.2	2.5	8.7	19	17.2	13.4	5.1	8.3
13	24.5	13.7	4.7	9	20	13.2	10.3	1.9	8.4
14	31	11.4	2.8	8.6	21	17.7	12.4	3.8	8.6
June 1	32.7	12.3	3.6	8.7	July 16	13	14.1	5.6	8.5
2	29.2	12.3	3.6	8.7	17	27.5	11.4	3.2	8.2
3	19.2	11.7	2.9	8.8	18	23.2	14	5.6	8.4
4	33.5	12.5	3.6	8.9	19	14.5	10.6	2.4	8.2
29	28	11.6	2.8	8.8	Aug. 25	14.5	11.5	3	8.5
30	24.2	16	6.6	9.4	26	9	13.3	5.1	8.2
July 1	25.7	11.9	3.4	8.5	27	14	12	3.2	8.8

This table shows four or more distinct kinds of variations. The records of May 9th and 10th illustrate the course the milk had been taking for some time. May 11th there was an increase of 10 lb. in the milk and a considerable increase in its quality; May 12th both decreased; May 13th the pounds of milk descended, the quality ascended; May 14th the reverse was true; from June 1st to 4th there was a rising and falling in the quantity of milk of over 14 lb., but the quality remained nearly unchanged; June 30th the milk tested 6.6 per cent fat and the day before was 2.8 per cent, with a change of only 4 lb. in the quantity. These and the other groups of tests given in the above table show that with this cow there was no uniform relation between quantity and quality. A change in one was sometimes accompanied by similar variation in the other; and there were times when these deviations did not coincide. At other times one changed very noticeably and the other did not. The uniformity in the per cent of solids not fat, amidst all these changes, is very noticeable.

The record of cow No. 5 shows no such sudden changes as the above. The daily weights of milk varied only 3 lb. and the per cent of solids and fat were very uniform until the last month of the period of lactation, when there was an increase in quality.

The per cent of solids found during the 322 days was between 12 and 14, except on 17 days when it went above 14, but only twice above 15.6; and on 27 days, below 12 per cent solids, but never below 11 per cent. The average per cent of fat was 3.7, it ran up to 8 on one day only, and was above 4.5 per cent on 19 days; 2.2 per cent was the minimum which it reached once, and only 10 times in the year was it below 3 per cent. The per cent of solids not fat went above 9.5 on 14 days and below 8.5 on 28 days, although it was 8.4 on 13 of these 28 days.

The table on page 146 gives the number of samples of milk out of the total number tested for cow No. 1 that went above and below certain percentages of solids, fat, and solids not fat. The following table shows the same for the other 5 cows, except that the standards are lower.

It also shows that by far the greater number of samples containing over 14 per cent solids were between 14 and 14.5 per cent. Those under 12 per cent solids were mostly between 12 and 11.5 per cent. A very large proportion of those over 4.5 were between 4.5 and 5 per cent fat, and those under 3 were nearly all included between 3 and 2.5. The per cent solids not fat went a few times over 10 per cent, but hardly ever under 8 per cent.

Different standards were adopted for the milk of cow No. 1, and a summary of the variations in her milk is given on page 146.

NUMBER OF DAYS WHEN PERCENTAGES OF SOLIDS, FAT, AND SOLIDS NOT FAT WERE ABOVE OR BELOW CERTAIN STANDARDS.

Period of lactation—Cow No. 3, 428 days; No. 16, 332; No. 18, 342; No. 4, 278; No. 5, 322.

Per cent solids.	Per cent solids over 14 and under 12.					Per cent fat.	Per cent fat over 4.5 and under 3.					Per cent solids not fat.	Per cent solids not fat over 9.5 and under 8.5.				
	No. 3	16	18	4	5		No. 3	16	18	4	5		No. 3	16	18	4	5
14-14.5	15	32	28	8	9	4.5-5	19	24	21	17	9	9.5-10	81	86	100	6	10
14.5-15	6	9	10	4	3	5-5.5	10	5	10	6	5	10-10.5	8	15	10	2	1
15-16	4	6	9	1	4	5.5-6	5	3	6	1	4	10.5-11	2	3	2	2	1
16-17	2	1	2	1	...	6-7	2	...	...	1	...	11-11.5	...	...	...	...	2
17-18	1	...	1	...	1	7-8	2	...	1	...	...	12	...	...	...	...	...
18-19	...	1	...	...	...	8-9	...	1	...	1	1	....	...	...	...	...	...
Sum....	28	49	50	14	17		38	32	38	26	19		91	105	112	10	14
Per cent of whole No..	6.5	15	15	5	5		9	9	11	9	6		21	31	33	3	4
12-11.5	29	6	19	...	25	3-2.5	18	8	22	58	9	8.5-8	11	...	8	25	26
11.5-11	4	4	4	...	2	2.5-2	...	2	3	10	1	8-7.5	...	2	2	7	4
11.5-10	3	...	2	15	...	2-1.5	...	2	...	4	...	7.5-7	2	...	...	1	...
10-9.5	...	...	1	...	...	1.5-1	...	...	...	...	...	7	...	...	...	...	...
9.5-9	...	...	...	...	...	....	...	...	...	...	...	....	...	...	...	...	...
Sum....	37	10	26	15	27		18	12	25	72	10		13	2	10	33	30
Per cent of whole No..	9	3	7	5	8		4	3	7	26	3		3	6	3	12	9

TOTAL PRODUCTION OF THE COWS.

The following table shows the difference between the cows in total production and daily average during the year. The figures for milk, milk solids, and fat are found from the daily weights and analyses. The butter equivalent of the butter fat is found by multiplying the pounds of fat by 1.2, as recommended by Fleischman. (*Landw. Jahr.*, *Band XX.*) The butter found by the use of this factor (1.2) contains 83.33 per cent fat. Such a calculation does not take into account the butter fat lost in creaming and churning the milk. Fleischman suggests that this loss is about 6 per cent of the total product.

DIFFERENCE IN TOTAL PRODUCTION AND DAILY AVERAGE COMPOSITION.

Cow No.	Ave. live wt., lb.	Milking period, days.	Total product, lb.				Average composition of milk.		
			Milk.	Solids.	Fat.	Butter.	Solids, per cent.	Fat, per cent.	Solids not fat, per cent.
1	859	307	5044	729	254	305	14.4	5	9.4
3	1022	428	6193	794	228	274	12.8	3.7	9.2
16	1108	332	3738	496	146	175	13.3	3.9	9.4
18	1174	342	3069	400	115	138	13.1	3.7	9.4
4	1361	278	6032	718	198	238	11.9	3.3	8.6
5	1054	322	7106	885	262	314	12.4	3.7	8.7

This table shows that the most milk was given by No. 5 and the least by No. 18. The richest milk throughout this entire period of lactation was given by No. 1, the poorest by No. 4. The richest but not the most milk was given in this lot by the smallest and youngest cow. The most and nearly the thinnest, by one of the largest and oldest cows. These differences in size and in quantity and quality of the milk are characteristics of the two breeds to which these two cows belong; hence in this experiment it cannot be justly said that a small or young cow produces a small amount of rich milk, or that a large quantity of thin milk is a characteristic of an old or large cow. There may, however, be some relation between the age or size of the cow and the amount and richness of the milk she produces, dependent somewhat on the food she eats and assimilates.

The table also shows that one cow was milked only 278 days, and another 428 days; one weighed 859, and another 1361 lb. Calculating the record of each cow for a uniform length of time and live weight, as 300 days and 1,000 lb., gives the following results:

TOTAL PRODUCTION COMPARED WITH LIVE WEIGHT.

Cow No.	Age July, '91, years.	How many times the live weight.		Pounds per 1000 lb. live weight.					
				For whole time.		For 300 days.		Per day.	
		Milk.	Butter.	Milk.	Butter.	Milk.	Butter.	Milk.	Butter.
1	3	5.9	.35	5,870	355	5,739	345	19.13	1.15
3	3	6	.26	6,069	268	4,248	186	14.16	.62
16	8	3.4	.16	3,375	158	3,048	141	10.16	.47
18	7	2.6	.12	2,614	118	2,292	102	7.64	.34
4	8	4.4	.18	4,432	175	4,782	189	15.94	.63
5	8	7.7	.30	6,742	298	6,279	276	20.93	.92

The total amount of milk and butter produced per 1,000 lb. live weight is calculated by multiplying the yearly product by 1,000 and then dividing by the average live weight of the cow. This result divided by the number of days which the cow was milked gives the figures per day, and multiplying these by 300 shows the performance of each cow for the same live weight and length of milking period. When these cows are compared on this basis the figures for weight of milk produced, place them in the following order: No. 5 first, No. 1 second, No. 4 third, and then No. 3, 16, and 18. Comparing them as butter producers per 1,000 lb. live weight and 300 days milking period puts No. 1 in the front rank, No. 5 second, and the others in the following order: No. 4, No. 3, No. 16, and No. 18.

The difference in value to the owner of two cows like No. 1 and No. 18, whose feed was the same, which were milked the same length of time, and were of uniform weight, but produced 345 and 102 lb. butter respectively, teaches a lesson in profit and loss and shows what contrasts can be often found, probably, when cows' records are investigated by weights and tests.

The maximum and minimum figures for the year illustrate a possible error which might be made if it should so happen that an opinion of a cow's milk capacity was formed from one test only, if this test had been made on the day when either one of the extreme results had been observed. The highest and lowest per cent of solids, fat, and solids not fat on any day during the whole period of lactation are as follows:

Extreme Variations during Period of Lactation—Per cents.

Cow No.	Total solids.		Butter fat.		Solids not fat.	
	Extremes.	Difference	Extremes.	Difference.	Extremes.	Difference.
1	11.9–22.4	9.5	2.9–12.3	9.4	7.6–11.7	4.1
3	10.8–17.8	7	2.5– 7.9	5.4	7.2–11.3	4.1
16	11–19.4	8.4	1.8– 9.2	7.4	8.5–10.7	2.2
18	10.2–17.8	7.6	2– 8.1	6.1	8–11	3
4	9 1–17.1	8	1.5– 6.6	5.1	7.2–10.9	3.7
5	11–17.8	6.8	2.2– 8	5.8	7.8–11.6	3.8

Calculated Total Production of Milk and Butter Fat.

The exact total production of milk and butter fat in the milk of each cow was found from the sum of the numbers obtained by the daily weights and tests.

These records furnish the data for calculating the total production of each cow from weights and tests made only one, two, three, or four times each month and for comparing the yearly amount thus obtained with that found from the daily weights and tests.

The accuracy of such a computation depends a great deal on the cow. If the flow of milk decreases gradually from the time the cow is fresh until she is dry, and there are no sudden fluctuations in the quality from day to day, her total production for the whole period of lactation can be quite accurately calculated from comparatively few weights and tests. A cow that does not give milk of uniform quantity or quality, but varies more or less from day to day, requires a greater number of weights and tests of her milk to make such a calculated product agree with that found from daily weights and tests.

The records of the six cows used in this experiment show quite a difference in milk production. They differ not only in the total production but in the relative amount of the total which is produced in the different parts of the milking period. Some gave the most milk when they were fresh, but others reached their maximum a few months after calving. This increase in quantity of milk was caused by the feed. A cow calving in January gave more milk the following May on pasture feed. This may not be true of all cows, but it was observed with one of these. These changes in the periods of lactation, and the daily variations peculiar to each cow explain the variety of deviations from the total production found when the total production of these cows was calculated from the same number of weights and tests.

The method used for calculating the total production was as follows: Multiply the average per day of all the test days by the total number of days each cow was milked. If a cow was milked 300 days and the milk weighed and tested once every 30 days, there were 10 test days. The average weight of milk and butter fat found per day from these 10 test days multiplied by 300 gave the calculated total product. If the milk was weighed and tested once in 15, 10 or 7 days there were 20, 30, or 43 test days, from which the daily average was obtained and multiplied by 300 in each case.

The following table illustrates the details of a calculation of the total milk product of cow No. 1, found from tests made once in 30 days.

METHOD OF CALCULATING MILK PRODUCT FROM TESTS EVERY 30 DAYS.

Milking period Oct. 6, 1891, to August 8, 1892.—307 days.

Test day.	Pounds, milk.	Per cent.		Pounds.	
		Solids.	Fat.	Solids	Fat.
November 4....	20.5	13.5	4.7	2.76	.96
December 4....	18.7	13.8	4.6	2.58	.86
January 3......	17.7	14.2	4.9	2.51	.86
February 2.....	20	14.1	4.5	2.82	.90
March 3.......	18.2	14.4	4.7	2.62	.86
April 2.........	19.5	14.2	4.4	2.63	.81
May 2.........	17.7	14.5	4.8	2.57	.85
June 1.........	13	15.8	5.5	2.05	.72
July 1.........	12.2	16.3	6.2	1.99	.76
July 31........	3.2	18.1	7.2	.58	.23
Total........	159.7	....	....	23.11	7.81
Average......	15.97	....	....	2.31	.78
Average x 307, total for year.	4,903	....	....	709	240

The other calculations are made in the same way from weights and tests made once in 15, 10, and 7 days.

The results of an application of this method of calculation to the records of each cow, are given in the following tables. They show how near to the sum of all the daily weights and tests computed weights and tests can be obtained by making weights and tests once in 30, 15, 10 or 7 days, and what percentage of the whole the computed weights represent.

TOTAL PRODUCTION OF MILK AND BUTTER FAT CALCULATED FROM WEIGHTS AND TESTS MADE 1, 2, 3, AND 4 DAYS EACH MONTH.

	Milk.					Butter fat.				
Days between tests....	30	15	10	7	Daily.	30	15	10	7	Daily
Cow No. 1.										
Total pounds..........	4903	4970	5105	4973	5044	240	240	256	246	254
Varies from daily lb...	141	74	61	71	0	14	0	2	8	0
Per cent of daily......	97.2	98.5	101	98.6	100	94.5	90.9	100.8	96.9	100
No. of weights and tests	10	20	30	44	307	10	20	30	44	307
Cow No. 3.										
Total pounds..........	6020	6076	6191	6121	6193	224	223	229	234	228
Varies from daily lb...	173	117	2	72	0	4	5	1	6	0
Per cent of daily......	97.2	98.1	100	98.8	100	98.3	97.8	100.4	102.6	100
No. of weights and tests	14	28	42	61	428	14	28	42	61	428
Cow No. 4.										
Total pounds..........	6075	5900	5862	6004	6032	202	189	189	189	198
Varies from daily lb...	43	132	170	28	0	4	9	9	9	0
Per cent of daily......	100.7	97.8	97.2	99.5	100	102	95.4	95.4	95.4	100
No. of weights and tests	9	18	27	40	278	9	18	27	40	278
Cow No. 5.										
Total pounds..........	7232	7181	7084	6955	7106	273	266	264	261	262
Varies from daily lb...	126	75	22	151	0	11	4	2	1	0
Per cent of daily......	102	101	99.6	98	100	104	101.5	100.8	99.6	100
No. of weights and tests	10	21	32	46	322	10	21	32	46	322
Cow No. 16.										
Total pounds..........	3396	3619	3559	3635	3738	136	148	152	145	146
Varies from daily lb...	342	119	179	103	0	10	2	6	1	0
Per cent of daily......	90.8	96.8	95.1	97.2	100	93.2	101.4	104	99.3	100
No. of weights and tests	11	22	33	47	332	11	22	33	47	332
Cow No. 18.										
Total pounds..........	2770	3037	2896	2948	3069	103	113	109	109	115
Varies from daily lb...	299	32	173	121	0	12	2	6	6	0
Per cent of daily......	90.3	93.4	94.4	96.1	100	89.6	98.2	94.8	94.8	100
No of weights and tests	11	22	34	49	342	11	22	34	49	342

CALCULATIONS FOR TOTAL WEIGHTS OF MILK AND BUTTER FAT COMPARED WITH DAILY WEIGHTS AND TESTS.

Cow	No. 1.	No. 3.	No. 4.	No. 5.	No. 16.	No. 18.	Average.	Deviation from 100.
	Weights of milk, percentages.							
Weighing daily........	100	100	100	100	100	100	100	....
Once in 7 days......	98.6	98.8	99.5	98	97.2	96.1	98	-2
Once in 10 days.....	101	100	97.2	99.6	95.1	94.4	98	-2
Once in 15 days.....	98.5	98.1	97.8	101	96.8	93.4	97.6	-2.4
Once in 30 days....	97.2	97.2	100.7	102	90.8	90.3	96.4	-3.6
	Weights of butter fat, percentages.							
Testing daily........	100	100	100	100	100	100	100	....
Once in 7 days......	96.9	102.6	95.4	99.6	99.3	94.8	98	-2
Once in 10 days.....	100.8	100.4	95.4	100.8	104	94.8	99.4	- .6
Once in 15 days.....	96.9	97.8	95.4	101.5	98.2	98.2	98.5	-1.5
Once in 30 days.....	94.5	98.3	102	104	93.2	89.6	97	-3

A summary of these results, given in the last table, shows what percentages of total production were found when one to four weights and tests per month were made of the milk of these cows.

The summary tables show that for calculating the total weight of milk produced by all these cows, weighing the milk once in seven days, gave nearest to the total amount found by daily weighings. This was not true of every cow, as the table shows that with two cows weighing the milk once in 10 days gave a total nearer that found by the daily weighings. The records of all the cows show that the difference between the extreme percentages of the whole amount was least by weekly weighings, and greatest when the milk was weighed once in 30 days.

Weighing milk once in	7 days.	10 days.	15 days.	30 days.
Highest percentage	99.5	101	101	102
Lowest percentage	96.1	94.4	93.4	90.3
Difference	3.4	6.6	7.6	11.2

The table also illustrates the variety of results that are obtained by applying this method of calculation to different cows. No. 16 and 18 were very irregular in the quantity of milk given from day to day. Weighing their milk weekly gave only 96 to 97 per cent of the total found by daily weighings, while so small a percentage of the whole was only found with the other cows when their milk was weighed once in 30 days.

The results from these six cows show that calculations of the total weight of milk produced in one period of lactation gave from 96.1 to 99.5, average 98, per cent of the total quantity, when the milk was weighed on one day of each week; 101 to 91.4, average 98, per cent, when weighed once in 10 days; 101 to 93.4, average 97.6, per cent, when weighed once in 15 days; and 102 to 90.3, average 96.4, per cent, when weighed once in 30 days.

These same observations apply to the calculation of the total production of butter fat.

Testing the milk once in	7 days.	10 days.	15 days.	30 days.
Highest percentage	102.6	104	101.4	104
Lowest percentage	94.8	94.8	95.4	89.6
Difference	7.8	9.2	6	15.4
Average of the six cows.	98	99.4	98.5	97

The average of all the results shows that weighing and testing the milk every seventh day gave with these six cows 98 per cent of the total milk, and 98 per cent of the total butter fat; 98 per cent of the milk, and 99.4 per cent of the butter fat, when weighed and tested every tenth day; 97.6 per cent of the milk and 98.5 per cent of the butter fat, when weighed and tested every fifteenth day; 96.4 per cent of the milk and 97 per cent of the butter fat, when weighed and tested every thirtieth day.

Does an Increase in the Grain Ration fed to Cows influence the Richness of the Milk?

This question has been often discussed and among the many opinions that are expressed two at least seldom fail to be given: First, taht rich feed makes rich milk, and second, that the milk may be increased in quantity but not in quality. These statements are supposed to apply to the milk of one cow during one period of lactation. It is obvious that a certain amount of food is necessary to keep a cow in such condition that she neither gains nor loses weight. This maintenance ration is a variable quantity differing with cows of various sizes. It is greater for a cow weighing 1200 lb. than for an 800-pound cow. The disposal that is made of any excess of food over maintenance probably depends on the natural capacity of the cow. One may convert the excess into live weight; another will show an increase in milk; and it is probable that others gain neither in weight nor milk, the excess of feed passing them unassimilated.

Without further discussing the question or expressing an opinion, the following evidence in the shape of weights and analyses of feed and milk has been obtained from the daily records of three cows, No. 1,-3, and 5. The history of the cows and of their care and feed up to Dec. 25th has already been given on p. 140. The changes in the daily feed per head of these cows after Dec. 25th are shown in the following table:

FEEDING PERIODS; MATERIALS FED, AND WEIGHTS OF EACH IN POUNDS.

	Feeding Period.	Corn and cob meal.	Wheat bran.	Oil meal	Timothy hay	Corn ensilage
1	Dec. 1–Dec. 25................	—	—	2	10	20
2	" 25–Jan. 6.................	6	4	2	6	20
3	Jan. 6–Feb. 2.................	8	4	4	12	—
4	Feb. 2– " 17.................	10	5	5	12	—
5	" 17–Apr. 8.................	12	6	6	12	—
6	Apr. 8– " 14.................	12	—	6	12	—
7	" 14– " 30.................	—	—	6	22	—
8	" 30–Sept. 1.................	pasture	only.			

The cows had access to a straw stack when in the yard during the winter; but as this was only a short time each day, and as their grain ration was heavy, there probably was little straw eaten by these cows after the first feeding period.

This course of feeding was tried for the purpose of increasing the richness of the milk if such a thing were possible. The table shows that the total grain feed per day and head was gradually increased from 12 to 24 lb. and the latter quantity, which was a high feed for these cows, was continued for two months. The change from a grain feed of 24 lb. to pasture feed and no grain was made gradually, as the table shows.

A chemical analysis was made of these feeding stuffs and, by the use of the digestion coefficients published by Professor Jordan, a calculation shows that 100 lb. of each feed contains pounds of digestible nutrients as follows:

Pounds Digestible Nutrients in 100 Pounds Feed.

	Corn and cob meal.	Wheat bran.	Oil meal.	Timothy hay.	Ensilage.	Oat straw.
Organic matter........	66.7	54.2	65.6	49.8	24.5	43.6
Protein...............	7	12.9	25.6	3.1	1.6	1.4
Crude fiber............	2	3.2	3.5	17	4.9	21.8
Nitrogen free extract...	54.7	34.5	27.5	28.2	17.1	19.4
Fat (ether extract).....	3	3.6	9	1.5	0.9	1
Total dry matter not the digestible............	86.3	89.7	87.6	91	38.6	90.4

An exact record of the weight of feed each cow had before Dec. 25th the writer was not able to obtain, as the ensilage or straw was not weighed; but assuming that the cows each ate 20 lb. of ensilage daily with 10 lb. of hay and 2 lb. of oil meal, the digestible nutrients consumed per day and head are given in the following table. Each period includes the time a ration was fed without change.

The live weight of cows No. 3 and 5 was between 1,000 and 1,100. No. 5 did not gain much during this course of feeding. No. 3 increased in weight from 912 lb. to 1097 lb. No. 1, from 800 lb. to 900 lb.

The figures of the table (page 164) show the digestible nutrients for very nearly 1,000 lb. live weight with No. 3 and 5, but for cow No. 1 they would be somewhat larger as her average weight was about 850 lb.

The table also gives the average daily yield of milk and its composition during each feeding period.

The feeding stuffs that are consumed by cows contain some water, which is sufficient in many to make them juicy, while in others it is only perceptible by the loss in weight that occurs when they are heated at such a temperature that none of the vegetable matter is volatilized. The dry matter is the water free substance of the feed. A certain part of the dry matter is digestible. The rest passes the animal undigested. Both may contain the same constituents but the digestible portion is of greater interest to feeders.

A chemical analysis of a feeding stuff shows approximately the different groups of substances contained therein. Protein is the name given to that group which contains nitrogen in addition to the carbon, hydrogen and oxygen. This nitrogenous part is the "hearty" portion of the feed, the "flesh former," that group which beans contain in a large quantity and is nearly lacking in rice; or among cattle foods a large amount of protein is found in cotton seed meal and very little in wheat straw. The carbohydrates include the starch, sugars, and cellulose, and with the fats make what is often called the "heat forming" part of the feed. The nutritive ratio shows how many times the "heat formers" are greater than the "flesh forming" part of the feed; or the proportion of protein to the sum of the carbohydrates and fats. The method of calculating the potential energy and nutritive ratio is given by the writer in bulletin No. 9, p. 319, of this Station. The organic matter represents the sum of the protein, carbohydrates and fats. The standard feed given in the table represents what is called a sufficient and

Nutrients consumed and Milk Yield during the several feeding Periods.

	Feeding periods, 1891-2.	Nutrients consumed daily per head.							Amount and quality of milk produced.								
				Digestible.					Cow No. 1.			Cow No. 3.			Cow No. 5.		
		Dry matter, lb.	Organic matter, lb.	Protein, lb.	Carbo-hydrates, lb.	Fats, lb.	Potential energy, calories.	Nutritive ratio	Daily yield, lb.	Composition. Solids, %	Composition. Fat, %	Daily yield, lb.	Composition. Solids, %	Composition. Fat, %	Daily yield, lb.	Composition. Solids, %	Composition. Fat, %
1	25 days to Dec. 25.	18.58	11.18	1.13	9.54	.51	22001	1:9.4	16.7	13.89	4.64	11.5	12.73	3.81	25.1	12.32	3.58
2	12 days to Jan. 6 ..	23.72	15 34	1.94	12.63	.77	30348	1:7.4	18.4	14.44	5.24	14.8	13.14	3.76	29	12.43	3.88
3	27 days to Feb. 2 ..	24.91	16 07	2.45	12.7	.92	32071	1:6	19.9	14.25	4.91	16.3	13.1	3.57	31.1	12.3	3.71
4	15 days to Feb. 17.	28.41	18.65	2.98	14.51	1.16	37211	1:5.7	19.5	14.18	4.48	16.6	13.21	3.54	30.7	12.47	3.55
5	51 days to April 8 ..	31.9	21.13	3.5	16.34	1.29	42393	1:5.5	17.6	14.5	4.81	14.9	13.36	3.79	27.8	12.43	3.54
6	6 days to April 14..	26.5	17.89	2.73	14.08	1.08	35825	1:6	18.6	14.45	5	15.2	13.12	3.7	26.2	12.1	3.39
7	16 days to April 30.	25.25	14.88	2.21	11.8	.87	29729	1:6	13.6	15.6	5.97	12.5	13.71	4.27	19.4	13.14	4.02
8	31 days to June 1 ..	Luxuriant blue grass pasture.						1:4	16	15.1	5.2	14.5	13.79	3.66	22.5	12.6	3.4
	Standard.	24	15.5	2.5	12.5	0.5	28000	1:5.5									

well balanced ration for a milch cow—the nutrients consumed per day and per 1,000 lb. live weight.

Table on this page shows that during period 1 the feed of these cows was considerably below the standard, in everything except fats. Period 2 the protein was low. Period 3 the feed was very near the standard, except the fat, which was high. The maximum feed was reached in period 5, which was 51 days long. During this time the feed eaten by each cow daily was about 8 lb., or 33 per cent, above the standard in dry matter; 1 lb., or 40 per cent, above in protein, and .79 lb., or 158 per cent, above in fats. No bad effect was noticed from the 6 lb. of oil meal fed daily in this, or the following two periods, when the feed was gradually decreased until period 7. The 6 lb. oil meal and 22 lb. hay fed in period 7 reduced the ration to very near the standard, except that it was a little low in carbohydrates.

The nutritive ratio was somewhat narrowed from the first period.

When the cows were turned out to pasture no grain was fed. The grass in the pasture was excellent feed; but the month of May was very cold and rainy. This probably had an influence on the flow of milk.

The part of the table giving the weight and composition of the milk shows the average per day calculated from daily weights and tests during each period. The milk of each cow increased in quantity from periods 1 to 3. This increase amounted to 3 lb.

per day for No. 1; 5 lb. for No. 3; and 6 lb. for No. 5. The average per cent of solids was greater in period 2 than in 1 in the milk of No. 1 and 3, and but very little different in that of No. 5. The per cent of fat increased in the milk of No. 1 and 5, but decreased in that of No. 3 during period 2. After this time no great change in quantity or quality is noticeable in the milk of any of the cows until period 7. There was a slight decrease in the daily pounds of milk during the 111 days, between Dec. 25th and April 14th. This represents about one-third of the period of lactation, and it is probable that there would have been a much greater decrease if the feed had been less. The table shows that the quality of the milk did not increase by this long period of feeding which kept the quantity from decreasing, as it would naturally have done, with the progress of the lactation period. There is very little difference in the per cent of solids and of fat in the milk of the second and sixth periods, although during the intervening periods a ration very rich, in both protein and fat, had been fed for 93 days.

The record of each cow shows the same changes in the milk in periods 7 and 8. The nutrients in the daily feed were reduced nearly to the standard in period 7. The daily milk yield of the different cows decreased from 3 to 7 lb.; but the richness of the milk increased in every case. This amounted to about one per cent gain in both solids and fat in the milk of No. 1, and .5 per cent to one per cent in that of No. 3 and 5. The difference in feed was a substitution of 10 lb. hay for 12 lb. corn and cob meal. This made a reduction of 1.5 lb. dry matter, .5 lb. protein, and .21 lb. fats in the daily ration per head, and a difference in the coarseness of the feed represented by a change from 18 lb. grain, with 12 lb. hay to 6 lb. grain, with 22 lb. hay. This ration was fed only 16 days, and the indications are that if continued the cows would have soon gone dry in milk. When pasture feeding began there was an increase in the yield of milk from each cow. The quality of the milk decreased from what it had been during the 16 days of period 7, which immediately preceded; but the per cent of solids and of fat in the milk was about the same in the month of May on pasture feed, as it had been during the winter, when the cows were stable fed on a grain ration.

The table gives the average per cent of solids and fat in the milk produced during each of the periods, which were from 6 to 51 days in length. Such an average does not show the extremes that may occur in the amount and richness of the daily milk. The inequalities of quantity and quality from day to day are covered up by taking the mean production for a number of days. Twice in the period of lactation of these cows quite a sudden change was made in the flow of milk: first when the grain feed was increased during the winter stable feeding, and second when the cows were turned out to pasture in the spring.

The four following diagrams on pp. 167–170 show these changes as they occurred in the weight and composition of the milk from day to day. The first two and the fourth plates give the daily record of cows No. 1, 3, and 5 for a few days before and about 30 days after the grain ration was increased as indicated in the table. The third plate gives the record of cow No. 3 for a short time before and after pasture feeding began. Each diagram shows the record of one cow for 40 days, which are designated by a date every fifth day at the top of the diagram. The cows were weighed once a week and the live weight and date of weighing are indicated by the point where the dotted and solid part of the "weight of cow" line changes. The heaviest broken line on all the plates indicates pounds of milk, and this is numbered on the left hand margin of the record of cow No. 1, but by figures enclosed by a circle on the other plates.

The diagram for cow No. 1 shows the per cent of solids between the 13 and 14 per cent lines, per cent of fat between the 4 and 5 per cent lines, per cent of solids not fat between the 9 and 10 per cent lines, pounds of solids between the 2 and 3 pound lines, pounds of fat between the 0 and 1 pound lines, and pounds of solids not fat between the 1 and 2 pound lines. These percentages and pounds are indicated in the other three plates by the brackets and figures on the two sides of each diagram.

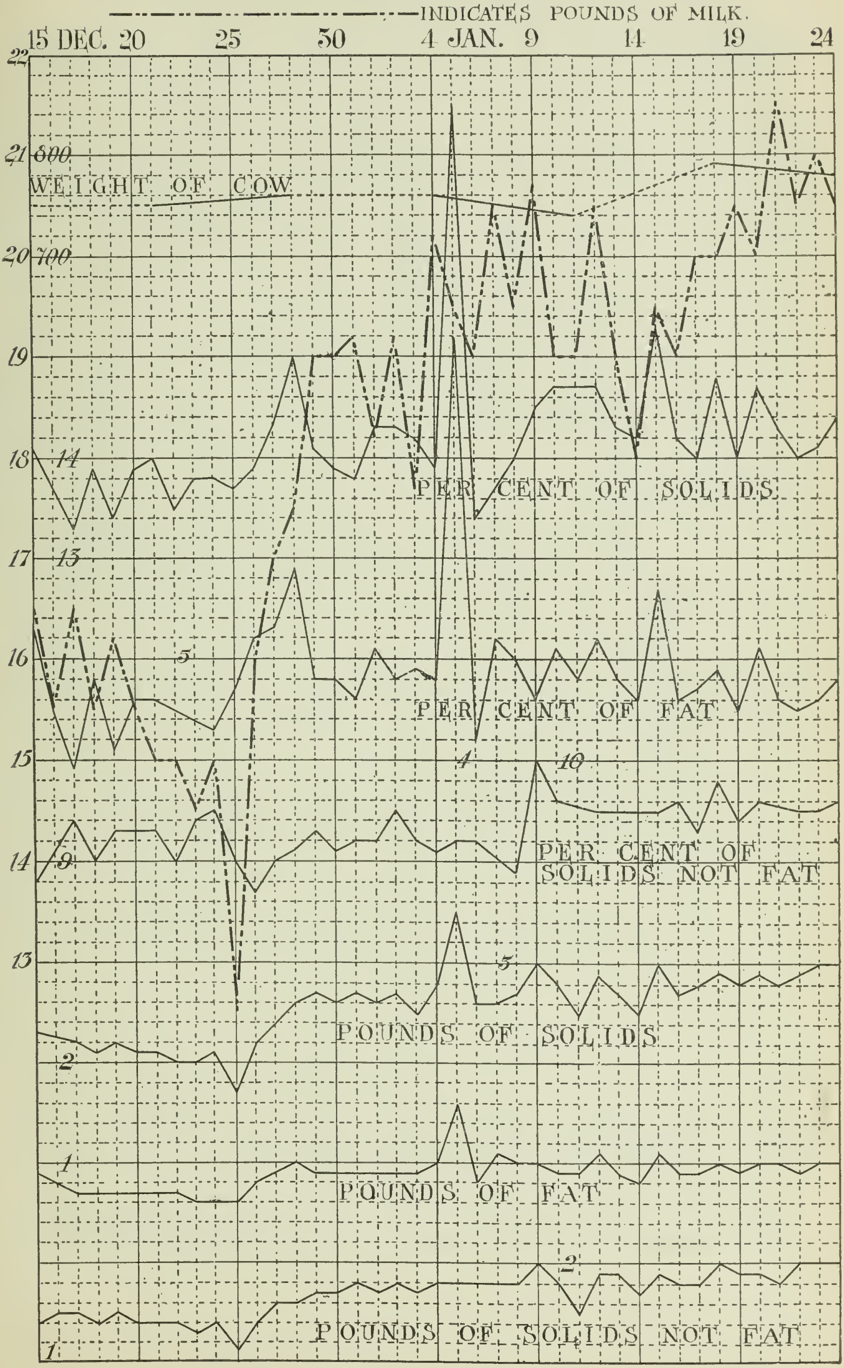
The grain ration was increased Dec. 25th and the change from stable to pasture made April 30th. All the records show that the increase of feed was accompanied by a considerable increase in the pounds of milk produced and consequently in the pounds of solids, fat, and solids not fat in the milk; but with the exception of one or two days, there were no greater changes in the percentages of fat in the milk after the increase of feed than before it was made. There was, however, a slight increase in the per cent of solids not fat in the milk of all the cows during the latter part of January, when the increased grain ration had been fed about a month.

All the striking changes in the composition of the milk produced on any one day are shown by the diagrams to be due to the per cent of fat. This is illustrated by the record of cow No. 1 on Dec. 28th, Jan. 5th and 15th; of No. 5 on Dec. 19th, Jan. 1st and 15th; of No. 3 on Jan. 10th, 23d, April 19th, May 7th, 9th, and 17th to 20th.

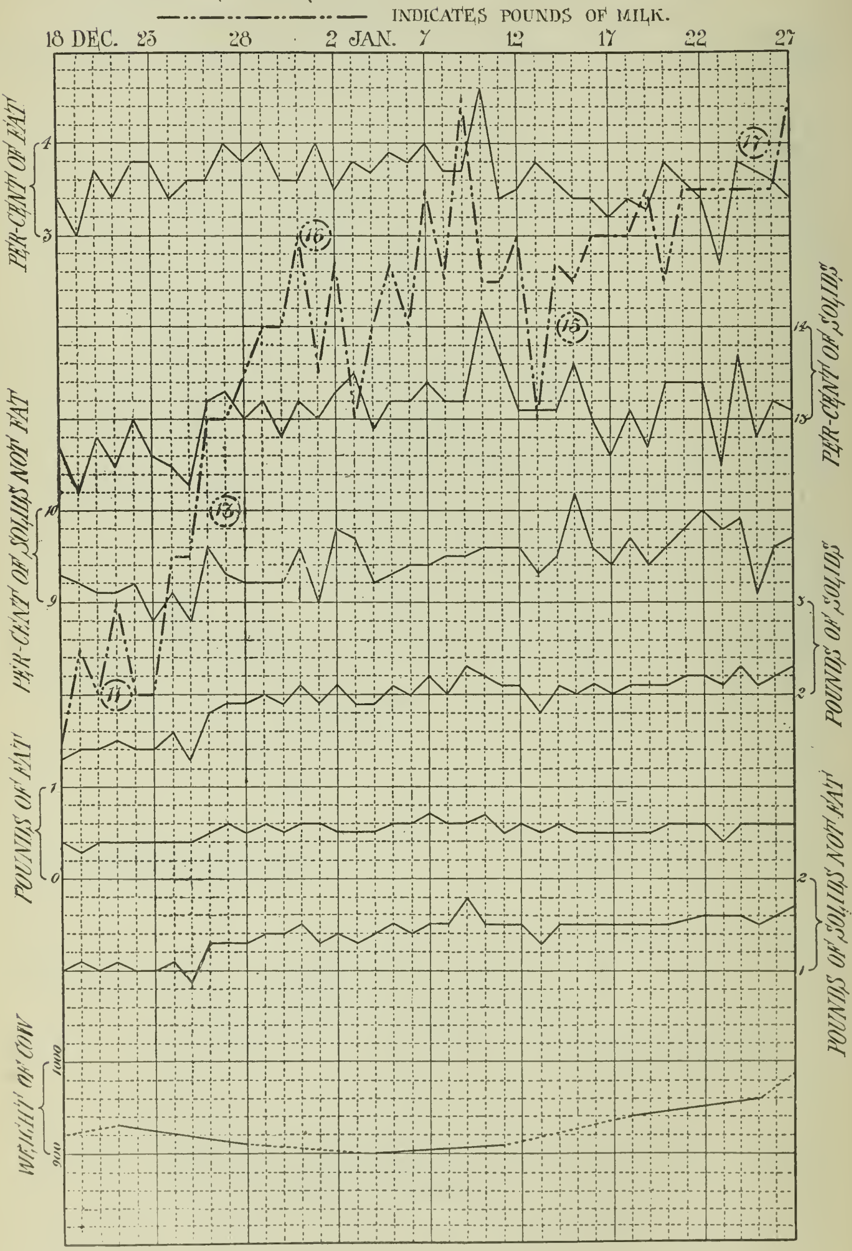
The increase in the daily weight of milk was greatest with cow No. 5. The diagram shows that she gave 22¾ lb. milk Dec. 23d, the quantity increased to 32 lb by Jan. 1st, a gain of nearly 10 lb. per day in a little more than a week.

No. 1 gave 8 lb. more milk Jan. 4th than Dec. 25th. No. 3 increased from 11 lb. Dec. 25th to 17½ Jan. 9th, and when she went from stable to pasture feed she gained in four days nearly 6 lb. milk

DAILY RECORD OF COW NO 1

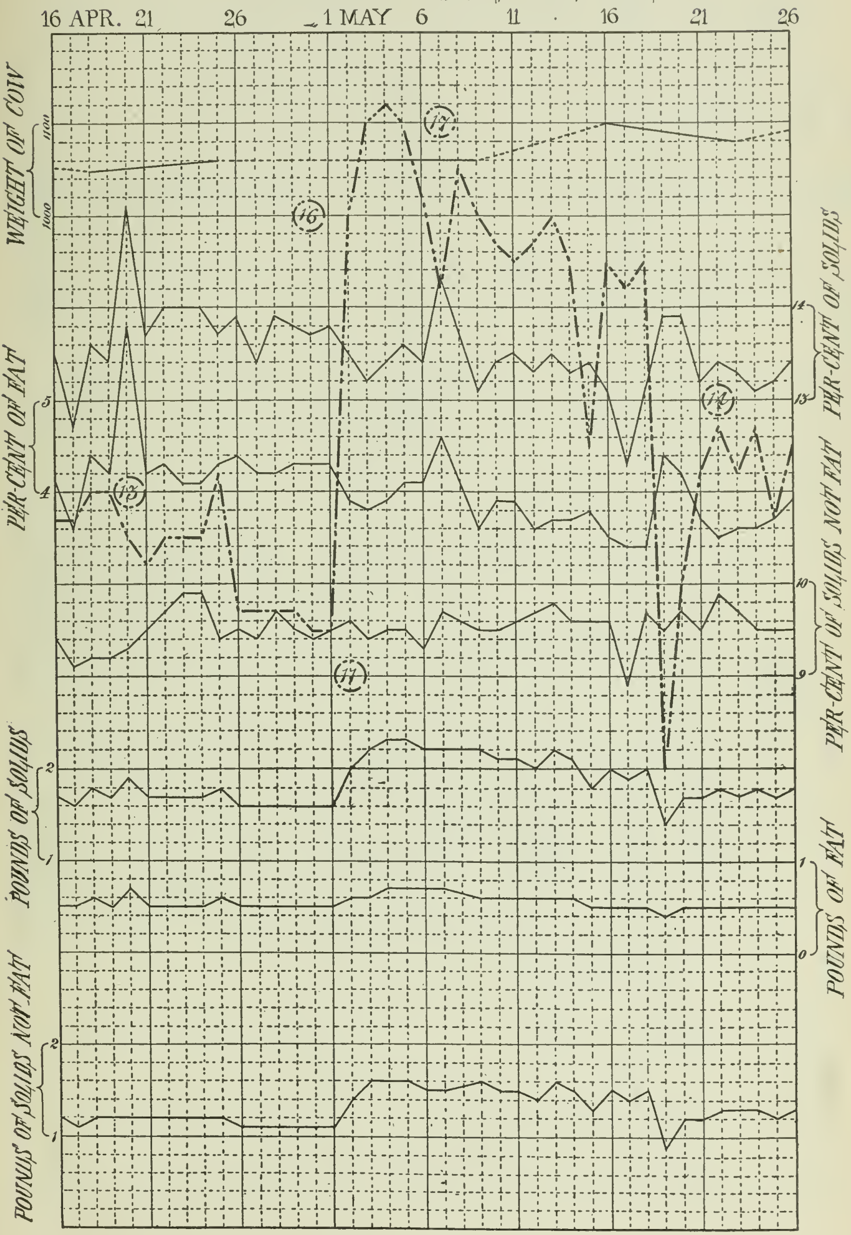


DAILY RECORD OF COW NO 3.



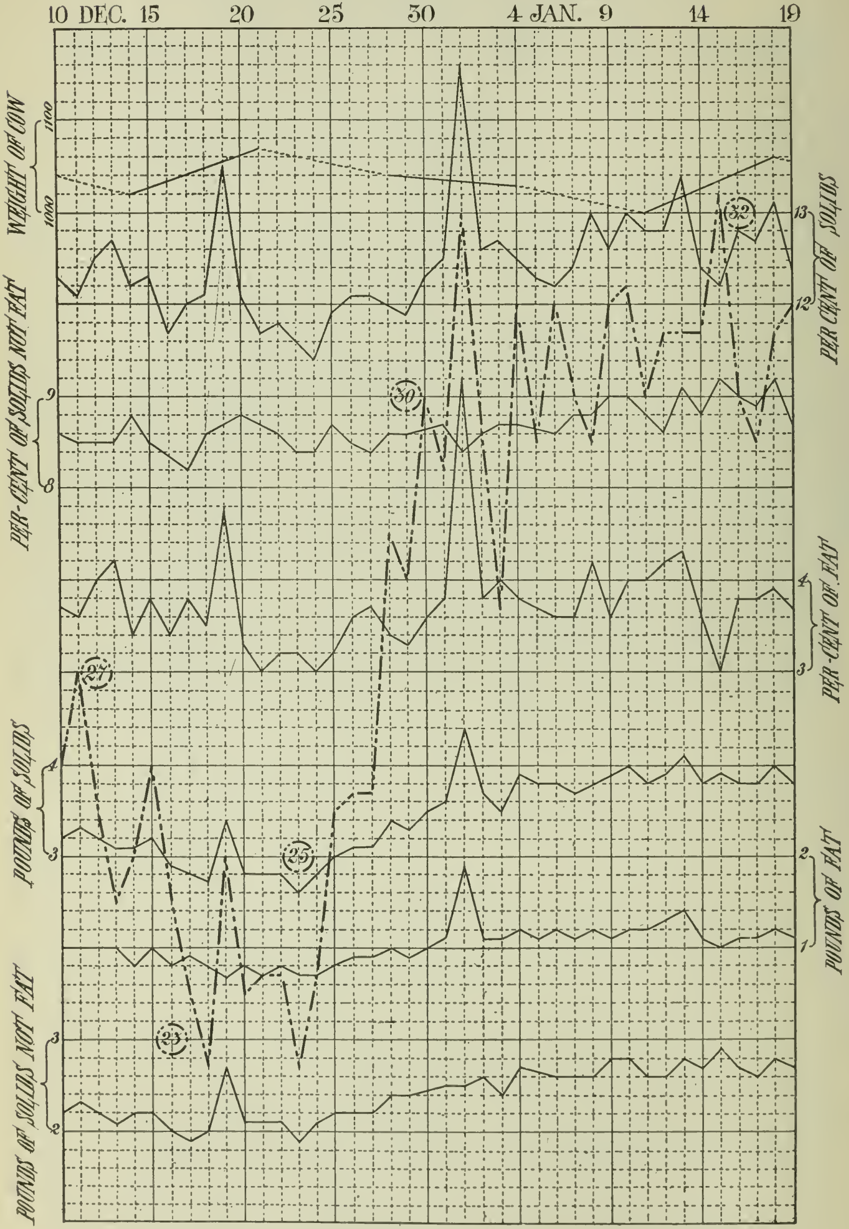
DAILY RECORD OF COW NO. 3.

–·–·–·–·– INDICATES POUNDS OF MILK.



DAILY RECORD OF COW NO. 5

– - - – - - – - - — INDICATES POUNDS OF MILK.



per day. The diagrams show that these changes in feed stimulated the milk production of the cows so that they each gave from 6 to 10 lb. more milk per day than they had been producing; but the quality of the milk was changed very little. The tables giving the record of each cow for the whole milking period also show that the milk was of the same uniform quality peculiar to the cow in every month, except the last ones when the cows were drying up. The average per cents of solids and of fat in the milk produced each month of the lactation periods do not show so great variations as were observed in some of the different feeding periods, which were considerably less than a month in length.

When the feed was decreased the yield of milk was diminished and the per cent of fat and solids in the milk was somewhat increased for a short time.

When the pasture is abundant the amount of feed eaten is regulated by the cow, and her milk product is probably then controlled by her natural capacity. If the quality of the milk is not changed by different amounts of grain feed from what it is on full pasture feed, it seems safe to assume from this evidence that the per cent of solids and fat in a cow's milk are not greatly influenced in one period of lactation by an increase of feed. The complete records of all these cows show some peculiarities in the milk production that are characteristic of each one and others that are common to all.

There were a few days during the milking periods when the milk was very much richer or thinner than ordinarily, but it soon returned to the quality peculiar to the cow. An inspection of the daily weights and tests made during the whole period of lactation of each of the cows shows that four different combinations of quantity and quality can be found in the milk of some of the cows; more and richer, more and thinner, less and richer, and less and thinner milk than was produced on the day before. Such changes were rare but they show that it is entirely inadmissible to assert that what one cow has done in this way another always can or will do.

E. H. FARRINGTON, M.S., *Chemist.*

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UNIVERSITY OF ILLINOIS,

Agricultural Experiment Station.

CHAMPAIGN, APRIL, 1893.

BULLETIN NO. 25.

FIELD EXPERIMENTS WITH CORN, 1892.

This bulletin gives the results of some experiments with field corn in 1892, together with a summary of the results obtained in the same experiments in 1888, 1889, 1890, and 1891.

The following are reported:

No. 1. Test of varieties.
No. 3. Time of planting.
No. 4. Depth of planting.
No. 5. Thickness of planting.
No. 6. Planting in hills or drills.
No. 8. Frequency of cultivation.
No. 9. Depth of cultivation.
No. 10. Effect of root-pruning.
No. 89. Cross fertilization.
No. 134. Effect of removing tassels.
No. 90. Growth of the corn plant; increase of its dry matter.

SUMMARY.

The experiments were tried on the dark colored, fertile, prairie soil common to central Illinois. The surface soil is about 18 inches deep, underlaid with yellow clay. In most cases the land had been in wheat or oats in 1891, and was plowed in the spring. The corn was planted by hand, covered with a hoe, generally with four kernels in hills 3 ft. 8 in. apart each way.

The season was exceptional in its character. The rainfall was excessive in May and June; below an average later in the season. For the five months—from May to September—it was 19.08 in., the average for this portion of the year being from 18 to 20 in. The average mean temperature for these five months was 67.4°, which is below the average during a series of years.

TEMPERATURE AND RAINFALL DURING THE CORN SEASON OF YEARS NAMED.

	Mean temperature, F.					
Year	May.	June.	July.	August.	Sept.	Average.
1887	67.9°	73.6°	80.4°	75.2°	66.4°	72.7°
1888	59.4°	71.3°	77°	72.4°	62.4°	68.5°
1889	59.2°	65.5°	72.7°	69.2°	61.3°	65.6°
1890	58.3°	74.6°	73°	68.7°	60.5°	67°
1891	58.4°	72°	70°	70.2°	69.2°	68°
1892	57.9°	70.6°	73.3°	71.5°	63.9°	67.4°
Average, 1878-87	64.6°	71°	77.5°	74.6°	66.5°	70.8°
	Rainfall, inches.					Aggregate
1887	3.84	1.62	1.65	2.56	3.68	13.35
1888	6.84	5.75	5.34	3.14	1.95	23.02
1889	5.52	6.81	5.84	.6	2.74	21.51
1890	3.56	3.8	2.83	1.93	1.19	13.31
1891	.89	2.08	1.41	2.86	.41	7.65
1892	7.86	5.36	2.5	2.43	.93	19.08
Average, 1878-87	4.45	5.04	2.75	3.45	3.27	18.96

Seventy-eight samples of corn, with different names, were tested on contiguous plats, each one-fortieth of an acre in extent. For the first time in five years, the late varieties gave the largest average yields, nine such varieties averaging 70 bu. Sixty-seven plats of medium maturing varieties averaged 68 bu.; sixteen plats of early maturing varieties averaged nearly 53 bu. For five years past, each of four medium maturing varieties has given yields of from 71 to 76 bu. per acre. The best early maturing variety has given in the same time average yields of 65 bu. per acre. For three years past the best yield by any variety was 83 bu. per acre, by Boone county white. The largest yield in 1892 was almost exactly 100 bu. per acre of air-dry corn, of the variety known as Piasa queen — a variety maturing too late for central Illinois. The trials for six years indicate that the larger medium maturing varieties give the best results. Among these the Boone county white, champion white pearl, and Burr's white represent the most satisfactory type of white, while the Leaming has given the best results among the yellow varieties. The Murdock has given the best yields of any early maturing variety, 65 bu. per acre, for five years.

Excellent varieties were obtained from many different places. Extravagant claims, such as yields of 100 bu. per acre under ordinary cultivation, or that any variety worth cultivating matures in 80 or 90 days, when planted at the usual time, are not to be accepted as correct. In ordinary circumstances, 100 days from date of planting may be considered as a minimum for field corn to mature fully; late varieties often need 150 days in central Illinois.

Repeated trials have uniformly shown that larger yields of both corn and stalks are obtained by planting a larger number of kernels than is customary in the best practice of Illinois. From 12,000 to 13,000 kernels planted per acre seem to be the minimum for largest yields at the Station grounds. This is equivalent to 4 kernels per hill, in rows at the usual distances for planting in Illinois. In most of the trials the rows were 3 ft. 8 in. apart each way. Twenty-four varieties were planted in as many plats; half of each having 3 kernels, and half 4 kernels in each hill. In 21 of the 24 cases, the larger yields were obtained from the thicker planting, the average increase for the 24 plats being about 4.5 bu. per acre.

Repeated trials have shown that, if other conditions are the same, there is no perceptible difference in average yield, whether the corn is planted in hills or in drills, the number of stalks secured influencing this rather than their mode of distribution. In many cases it is more difficult to keep drilled corn free from weeds. To secure the largest yield of both corn and stalks, medium maturing varieties may be planted at the rate of one kernel to each 3 inches, in rows 3 ft. 8 inches apart. Thick planting gives smaller ears, which increase the labor in husking. Where the corn is to be fed without husking, the smaller size of the ears may be an advantage.

As in each of several previous years, trials in 1892 show that shallow cultivation is better than deep, and that more frequent cultivation than is necessary to keep the soil free from weeds, and the surface fairly loose, is not profitable. On the Station grounds weeds were the chief enemy to the corn plant. Fair yields of corn have been secured in each of several years without any cultivation after planting, other than scraping the surface with a sharp hoe. Root-pruning has uniformly decreased the yield.

In 1892 the largest yields were obtained from planting April 30th, the soil being in better condition than at the later plantings The average results for five years show no great variation in the yield of medium maturing varieties, planted at any time during May. The earlier plantings have required more cultivation than the later ones. Within reasonable limits, time of planting seems to have less influence on yield than the condition of soil at time of planting.

In each of five cases, the yield from plats planted with cross-bred corn was larger than the average yield of the plats planted with the varieties which had been crossed; the average increase was over 9 bu. per acre. In four out of five cases plats planted with mixtures of different varieties of corn gave a less yield than the average of the plats planted with the same varieties separately, the average decrease being 3.7 bu. per acre.

A medium sized, medium maturing variety, planted June 3d, reached its maximum height August 19th, 77 days from planting. The dry matter continued to increase until the corn was fairly mature, September 16th. It had but little more than one-half the total quantity of dry matter when the stalks had reached their greatest height, and not more than one-third when tasseling began. In the week from July 22d to 29th, there was a growth of 28 inches, or 4 inches per day.

No noticable effect on yield was produced by removing tassels from alternate rows.

Trials at the Station show that the corn grown last year on the University farms, at Champaign, has less vitality than corn kept under like conditions any year for the last ten. Early maturing varieties show nearly perfect vitality; but not more than 80 to 85 per cent of the kernels of medium maturing varieties germinated under conditions more favorable than ordinarily met with in field planting.

Experiment No. 1. Corn, Testing Varieties.

Tests of varieties of dent corn have been made for six years, reports of which will be found in bulletins No. 4, 8, 13, and 20.

The land used in 1892 had been in wheat in 1891 and was seeded with clover. Barnyard manure was applied at the rate of about thirty loads per acre, and May 10th, after the clover had made considerable growth, the ground was plowed. Heavy rains prevented further preparation and planting until May 24th and 25th. The corn was dropped by hand in checks 3 ft. 8 in. apart and covered with a hoe.

The plats, 130 in number, were each one-fortieth of an acre, 2 rods or 9 hills square, and were so planted that corn was growing on every side. There were two plats of each of 24 varieties, one plat being planted three kernels per hill, and the other 4 kernels per hill. The remainder of the plats were planted 4 kernels per hill. June 10th to 28th they were all cultivated three times with a surface cultivator known as "The Superior." July 13th and 14th the remaining weeds were removed with a hoe. Just before cultivating the first time the number of hills and plants was ascertained for each plat. Frequent observations were made as to time of ripening. The number of barren stalks and average height to tip of tassels and to butt of ears were ascertained for each plat. The early varieties were husked Sept. 5th, the medium ones at several subsequent dates, and the late ones Oct. 11th. The plats were husked by thirds, the weight and number of ears being ascertained for each third. The middle third of each plat was at once shelled, the number and weight of both good ears and nubbins and the weight of both shelled corn and cobs being ascertained. A pint jar of the shelled corn from each plat was sent to the laboratory for the determination of water. Eleven per cent is taken as the average content of water in air-dried corn.

Duplicate Plats.

While the attempt was to have uniform soil and like treatment throughout, the differences in yield, as in former years, of plats planted with the same variety is considerable. There were four plats of each of the two varieties, Leaming and Murdock. The greatest difference in yield per acre between any two plats of the same variety was Murdock 11.9 bu., Leaming 18.9 bu.; the average difference, Murdock 6.3 bu., Leaming 11 bu.; and the least difference, Murdock .9 bu., Leaming .6 bu.

These differences, though considerable, are much less than those found between different varieties of even the same class. For example, the greatest difference between two plats of the 16 planted with early maturing varieties is 32 bu. per acre; of the 67 medium maturing, 43.4 bu.; and of 9 late maturing 39.5 bu. The variety giving the largest yield produced 2.9 times as much as the one giving the least.

When the variation in yield of different varieties does not exceed that of different plats of the same variety the results are inconclusive. A greater variation may properly be attributed, in part at least, to the variety. If single plats are used, it is only after varieties have been tested for a series of years that we can conclude which are the most prolific; but other things can be ascertained in a single year, such as time of maturity, size, ratio of ears to stalks, ratio of shelled corn to cobs, and the general characteristics of stalk and ear. If several plats, widely distributed over the tract, are used for each variety and the average yields ascertained, these form a better basis for a comparison of the varieties in respect to yield; for in this way the effect of differences in the condition of the test is much diminished.

Yield per Acre of Air-dry Corn upon Duplicate Plats, 1892.

	Variety.	From whom received.	a.	b.	c.	d.	Average.
	Murdock	W. T. Lamb	50.8	55	61.8	62.7	57.6
	Leaming	T. Chester	60.5	61.7	78.8	79.4	70.1

Leaming From Different Sources.

The medium maturing yellow variety, well known as Leaming, was received from seven different sources. As the differences in yield, from seed from different sources, though considerable, were not so great as between different plats planted with seed from the same source, it cannot be said that the difference was due to the seed coming from different sources. There was, however, considerable difference in the shape and roughness of the ears obtained from seed from different sources, showing the effect of different standards of selection.

LEAMING, FROM DIFFERENT SOURCES.

Plat No.	Leaming.	Date of ripening.	Per cent of water in shelled corn when husked.	Yield per acre.	
				No. of ears.	Bu. air-dry corn.
*	T. Chester, Champaign	Sept. 27	19.3	9,560	70.1
42	E. P. Kellenberger, Godfrey, Ill.	" 21	25.7	11,200	72.4
43	John McCabe, Hammond, Ill.	" 29	20.2	9,160	60.4
52	Currie Bros., Milwaukee	" 21	16.5	9,200	62.7
56	J. H. Beagley, Sibley, Ill.	" 21	22.5	9,800	63.4
63	S. S. Dunseth, Forrest, Ill.	" 21	15.9	10,840	74.1
68	University farm, Champaign	" 21	16.4	10,440	73.6

*Average 4 plats.

THREE KERNELS COMPARED WITH FOUR KERNELS PER HILL.

In only three out of twenty-four comparisons, with as many different varieties, between planting three and four kernels per hill, did three kernels give the larger yield. The average yield was 4.4 bu. per acre in favor of planting four kernels per hill.

COMPARISON BETWEEN 3 AND 4 KERNELS PER HILL, 1892.

Plat No.	Name of variety.	3 kernels per hill.			4 kernels per hill.		
		Total No. ears per acre.	Wt. 100 ears lbs.	Y'ld per acre air dry corn bu.	Total No. ears per acre.	Wt. 100 ears lb.	Y'ld per acre air dry corn bu.
4-5	Leaming	6760	58	54.3	8440	52	60.5
9-10	Pride of Kansas	7760	66	63.9	9160	57	63.4
14-15	Ivory dent	8160	68	72.9	13360	59	80.9
19-20	White surprise	6840	94	62.2	7960	84	60.3
24-25	Murdock	7960	46	49.1	10120	41	55
29-30	Baker's white	9040	40	52.1	10520	38	57.8
34-35	Bickerdike's early mammoth	8200	65	68	11520	52	70.6
39-40	Eclipse	7800	61	66.7	9640	52	61.2
44-45	Sterling	8040	60	65.8	9480	55	70.2
49-50	Clark's Iroquois	8480	57	70.2	10200	50	72.9
54-55	Pride of Columbia	8400	43	51.4	10840	38	58.5
59-60	California yellow	8200	61	70.3	10360	54	75.9
64-65	Clark's Onarga	9320	54	70.9	10960	52	77.4
69-70	Leaming	8120	69	74.6	10840	70	78.8
74-75	Branson's climax	8680	63	76.4	11360	51	77.5
79-80	Gibbs' yellow	8120	67	59.2	9600	61	75.1
84-85	Clarage	8480	58	59.5	10440	44	63.7
89-90	Blue River	7680	71	67.3	10320	53	68.9
94-95	Early Wisconsin	8200	48	51.6	7120	38	34.4
99-100	Clarke county champion	8400	51	55.4	10560	46	64.4
104-105	Dunlap's white	8800	68	71.8	11320	55	85.2
109-110	Edmonds	7760	58	56.7	9040	50	58.4
114-115	Pride of the north	8720	39	48.7	10280	36	54.2
119-120	Cloud's early	5960	70	51.3	7840	75	71.1
	Average	8078	59	62.1	10053	52	66.5

MIXTURES.

Four plats were planted each with equal parts of two varieties of corn, and one with equal parts of four varieties. The accompanying table gives the number of ears and bushels per acre for each variety planted separately, and their average as compared with the result of their mixture. In four out of five cases the mixtures gave smaller yields than the average of the varieties composing them. This may be due to the fact that there were fewer ears from the mixtures.

RESULTS OF MIXTURES, 1892.

Plat No.	Name of variety.	Yield per acre.	
		No. of ears.	Bu. air-dry corn.
91	Champion white pearl	10080	60.6
105	Dunlap's white	11320	85.2
	Average	10700	72.9
121	Mixture (a)	9920	70.3
	Murdock (av. 4 plats) (Lamb)	10500	57.6
110	Edmonds	9040	58.4
	Average	9770	58
122	Mixture (b)	9680	59.1
	Leaming (av. 4 plats) (Chester)	9560	70.1
65	Clark's Onarga	10960	70.9
	Average	10260	70.5
126	Mixture (c)	9560	67.2
50	Clark's Iroquois	10200	72.9
43	Leaming (McCabe)	9160	58.6
60	California yellow	10360	75.9
45	Sterling	9480	70.2
	Average	9800	69.4
127	Mixture (d)	9240	62.1
27	Boone county white	10040	85.5
13	Piasa king	10240	79.7
	Average	10140	82.6
128	Mixture (e)	9800	76.1

RESULTS FROM CROSS-BRED CORN.

Five plats were planted each from a different cross-bred ear. The accompanying table gives the date of ripening, number of ears, and bushels per acre for each parent, and their average, as compared with that of the cross. The first-named variety is in each case the female parent. In every instance the yield from the cross is greater than the average from the parent varieties; the average increase per acre from the five crosses being 9.5 bu. The fact that increased yields can be obtained by crossing two varieties is pretty certainly established, and a few farmers are changing their practice accordingly. This is quite easily done, by planting in one row one variety, and in the next another variety, and removing the tassels of the one as soon as they appear. The ears forming on the rows having the tassels removed, will be fertilized with pollen from the other rows, thus producing a direct cross between the two varieties. The seed should be selected from the rows having the tassels removed, and the experiments indicate that it will pretty certainly give a larger yield than the average of the parent varieties, when planted under like conditions.

RESULTS FROM CROSS-BRED CORN.

Plat.	Variety.	Date of ripening.	Yield per acre.	
			No. of ears.	Bu. air dry corn.
22	Burr's white	Sept. 29	9960	64.2
82	Cranberry	" 29	9200	61.6
	Average	" 29	9580	62.9
117	Cross	" 29	7080	64.1
22	Burr's white	Sept. 29	9960	64.2
18	Helms improved	Oct. 11	10880	79.2
	Average	Oct. 5	10420	71.7
118	Cross	Sept. 29	11000	73.1
68	Leaming	Sept. 21	10440	73.6
8	Golden beauty	" 29	8280	65.1
	Average	" 25	9360	69.3
123	Cross	" 29	11520	86.2
91	Champion white pearl	" 29	11080	60.6
68	Leaming	" 21	10440	73.6
	Average	" 25	10760	67.1
124	Cross	" 21	8760	76.2
22	Burr's white	" 29	9960	64.2
110	Edmonds	" 21	9040	58.4
	Average	" 25	9500	61.3
125	Cross	" 21	10400	78.5

CLASSIFICATION OF VARIETIES.

The table on page 182 gives a classification of the varieties tested this year, and the yield of air-dry corn by each variety. It is based upon the time of ripening, color, and smoothness or roughness of the outer end of the kernels. Varieties maturing before Sept. 16th are classed as early; those maturing Sept. 16th to Sept. 30th, as medium; and those maturing after Oct. 1st, as late. The varieties that are very near the dividing lines as to time of maturity, and smoothness or roughness, are subject from year to year to change from one class to another, hence we see that the classification for 1892 differs slightly from that of 1891.

SUMMARY OF RESULTS WITH THE THREE CLASSES—EARLY, MEDIUM, AND LATE MATURING—FOR EACH OF FIVE YEARS.

	Av. of plats, 1888.			Av. of plats, 1889.			Av. of plats, 1890.			Av. of plats, 1891.			Av. of plats, 1892.		
	27 early.	32 medium.	15 late.	3 early.	42 medium.	22 late.	14 early.	29 medium.	8 late.	13 early.	19 medium.	6 late.	16 early.	67 medium.	9 late.
Per cent kernels germinating in apparatus	96	97	90	93	97	96	96	94	93	......	......	......	96	89	93
Per cent germinating in field	84	80	74	70	68	65	81	86	81	87	88.4	87	91	87	85
Per cent full stand of stalks	88	87	85	84	80	78	79	83	79	86.1	86.4	84	81	82	80
Per cent of barren stalks	8	11	13	1.7	1.2	.5	10	12	13	10.4	12.6	14.8	8	9	10
Average height of stalks, feet	9.8	11.5	12.2	6.9	8.9	9.9	8.1	9.6	10.1	6.8	7.7	8.6	8.1	8.8	10.2
Average height of butt of ear, feet	4.5	5.5	6.2	2.8	4.2	4.7	3.5	4.5	5.2	3.4	4.2	4.3	3.7	4.3	5.4
Average length of 3 specimen ears, inches	8.3	9	9.7	7.4	8.1	9.6	8.1	8.3	8.4	7.6	8	7.5	7.7	8.4	8.8
Average circumference of 3 specimen ears, inches	6.3	7	7.2	6.2	6.4	7.2	6.4	6.6	6.2	6.2	6.6	6.2	6.1	6.6	7
Average circumference of 3 specimen cobs, inches	3.7	4	4.2	3.4	3.9	4.3	3.7	3.8	3.3	3.7	3.9	3.9	3.5	3.9	4
Number of good ears per acre	7597	7482	6263	6520	6695	6055	5374	5292	4651	5464	6334	5112	5242	5438	5011
Number of nubbins per acre	2948	2741	2745	3360	3535	3840	3610	3749	3806	4088	3400	3400	4681	4473	4064
Total number of ears per acre	10545	10223	9008	9880	10230	9895	8984	9041	8457	9552	9734	8513	9922	9858	9075
Weight of 100 good ears, lb	60	74	93	46	72	81	55	61.3	60.1	49.6	58.6	61.3	53	66	81
Weight of 100 nubbins, lb	35	33	51	26	40	43	28	31.9	34.1	28.5	31.6	33	25	35	47
Weight of 100 average ears, lb	53	68	80	39	61	67	44	50	48.7	40.2	48.8	49.8	41	53	69
Pounds ear corn to make bushel when husked	67.2	68.4	71.4	66.1	69.6	72	66.2	67.2	67.1	*66.3	*69.3	*67.7	68.1	68.4	71
Pounds ear corn when husked to make bushel air dry	73.3	78.1	87.8	70.6	81.1	90.2	70.4	73.3	78	72	75.8	86.8	77.4	76.6	89.9
Yield per acre from good ears, bu.	67.5	84	81.2	45.8	68.8	70	44.5	50	47.1	......	......	......	......	......	......
Yield per acre from nubbins, bu.	15.1	18	20.4	13.5	19.7	22.2	14.8	17.7	18.5	......	......	......	......	......	......
Yield per acre, total when husked, bushels	82.6	102	101.6	59.3	88.5	92.2	59.3	67.7	65.6	*58.2	*69.9	*63.9	60	75.8	88.1
Yield per acre air-dry corn, bu.	75.6	89.8	83.2	55.6	75.4	73.5	55.6	62	56.6	56.1	66.1	57.4	52.8	68	70.2
Loss in drying per acre, bushels	7	12.2	18.4	3.7	13.1	18.7	3.7	5.7	9	......	......	......	7.2	7.8	17.9
Per cent of water in corn when husked	18.3	21.8	27.2	16.6	23.8	28.8	16.5	18.4	23.2	*14.3	*15.9	*20.3	21.6	20.5	29.3

* When shelled.

SYNOPSIS OF VARIETIES, 1892.

					Yield.	Av.
Corn	Early	Yellow	Smooth	Minnesota king	35.9	51.1
				Murdock	66.4	
			Rough	Murdock	58.5	54.8
				Pride of Columbia	57.6	
				Thomas	63.1	
				Haber's early	47.9	
				Early Butler	45.2	
				Pride of the north	54.2	
				[Yellow variety, no name.]	47.1	
		Mixed	Smooth	Pusey's cross-bred	37.3	
		White	Smooth	Baker's white	57.8	48.9
				[White variety, no name.]	49.6	
				Callaway's white	54	
				Early Wisconsin	34.4	
	Medium	Yellow	Smooth	Leaming	71.8	68.8
				Golden beauty	65.1	
				Pride of Kansas	63.4	
				Bickerdike's early mammoth	70.6	
				[Yellow variety, no name]	77.8	
				" " " "	65.6	
				Woodhull	67.2	
			Rough	[Yellow variety, no name]	73.1	67.9
				Leaming	66.7	
				Farmer's interest	65.8	
				Fisk's yellow	60.1	
				Baker's yellow	63.9	
				Giant beauty	53.6	
				Golden beauty	61	
				B. O. E. ensilage	67.8	
				Eclipse	61.2	
				Early mastodon	49.6	
				Sterling	70.2	
				[Yellow variety, no name.]	65.3	
				Clark's Iroquois	72.9	
				Log cabin	71.8	
				Chester county mammoth	68.6	
				California yellow	75.9	
				Hughes	79.9	
				Clark's Onarga	77.4	
				[Yellow variety, no name.]	81.7	
				Steward's improved	74.4	
				Second premium	83.8	
				Prentice corn	59.7	
				Branson's climax	77.5	
				Legal tender	60.3	
				[Yellow variety, no name.]	77.2	
				Riley's favorite	74.1	
				[Yellow variety, no name.]	75.1	
				Clarage	63.7	
				Queen of the field	42.1	
				Edmonds	58.4	
				Munns	74.4	
				90-day	62.3	
				Cloud's early	71.1	
		Mixed	Rough	Leeper	57.1	58.9
				Calico	48.1	
				Cranberry	61.6	
				Blue River	68.9	
		White	Smooth	Hess white	74.4	72.4
				[White variety, no name.]	76.8	
				Kansas branching	74	
				Clarke county champion	64.4	
			Rough	Clark's 110-day	60.9	70.1
				Burr's white	64.2	
				Boone county white	85.5	
				Champion white pearl	62.8	
				Irony dent	80.9	
				[White variety, no name.]	81.7	
				White prolific	64.9	
				Ohio white dent	65.2	
				Early white dawn	64.8	
				Beard's pearl	54.9	
				Dunlap's white	85.2	

SYNOPSIS OF VARIETIES, 1892 — *Continued.*

				Yield.	Av.
Late	Yellow	Smooth	Farmers' favorite golden	69.7	
		Rough	Farmers' favorite	65.3	82.5
			Piasa queen	99.8	
	Mixed	Rough	Ensilage corn	60.4	
	White	Smooth	Helms improved	79.2	62.4
			White surprise	60.3	
			Hickory king	47.9	
		Rough	Piasa king	79.7	47.4
			Fisk's white	69.2	

RESULTS.

The number of plats in each of the three classes — early, medium, and late—and the results for each class for each of five years, are shown in the table on page 181. In each of the five years there has been an average of from four-fifths to seven-eighths of a full stand, *i. e.*, four stalks in each hill. In two years, 1888 and 1889, there were more stalks when the corn was ripe than when well up in the spring, showing that some stooling must have taken place. From the very low per cent of barren stalks in 1889 (1.5), we must conclude that most of the stalks produced by stooling must have borne ears. For 1888, 1890, 1891, and 1892, the per cent of barren stalks is comparatively uniform, averaging about eleven, and in each of these years it increases with the lateness of maturity.

Though varying much from year to year, owing to the nature of the season, in general the height of both stalks and ears increased with lateness of maturity, as do also the length and circumference of ears.

In general the weight of 100 ears has increased, and the number of ears per acre decreased with the lateness of maturing. The pounds of ear corn, as weighed when husked, which must be taken to make a bushel of air-dry shelled corn, invariably increases with the lateness of maturity. This is due largely to the fact that the per cent of water is greater in the late maturing varieties when husked. In two years of the five the pounds of ear corn as shelled required to make a bushel of air-dry shelled corn was less in the late maturing varieties than in the medium.

Each year, excepting 1892, the medium maturing varieties have made the largest yield; the average yield of air-dry shelled corn for the five years being 72.3 bu. per acre, which is 13.2 bu. more than the average of the early maturing, and 4.1 bu. more than that of the late maturing varieties.

Boone county white, a medium maturing variety, seed obtained from James Riley, Thorntown, Ind., has been tested for the past three years, giving an average yield of 83.1 bu. per acre. This is eleven bu. more than the average of any other variety tested during the same three years. In 1892, the largest yield, 99.8 bu. per acre, was made by Piasa

VARIETY OF CORN; SOURCE OF SEED; GERMINATION; STAND; BARREN STALKS; HEIGHT OF STALKS, OF EARS; SIZE OF EARS, OF COBS, 1892.

Plat.	Name of variety.	Source of seed received.		Percentage g'm'g in Geneva apparatus.	Percentage germinating in field.	Percentage of full stand of stalks.	Percentage of barren stalks.	Date of ripening.	Height, ft.		Av. of 3 specimen ears.		
									Stalks.	Ears.	Length, in.	Circumference ear, in.	Circumference cob, in.
1	Murdock	Wm. T. Lamb	Ridott, Ill	98	90	81	8	Sep. 10	7.7	4.1	7.7	6.2	3.9
2	Ensilage corn	I. N. Shannon	Goodlettsville, Tenn.	96	93	74	16	Oct. 11	10.4	5.6	8.2	7.6	4.2
3	[Yellow variety, no name]		Lincoln, Ill	100	95	84	5	Sep. 21	9	5.1	9.2	6.8	4
4	Leaming	T. Chester	Champaign	92	93	88	18	" 21	7.3	3.8	8.2	7.2	4.6
5	"	" "	"	92	92	83	18	" 21	8.4	4.1	8.5	7	4.3
6	Giant beauty	Johnson & Stokes	Philadelphia	90	62	55	10	" 29	7.9	3.7	8.4	7.7	4.7
7	Golden beauty	W. W. Barnard & Co	Chicago	96	66	61	4	" 21	9.6	4.9	8.9	6.8	4
8	Golden beauty	Wm. H. Maule	Philadelphia	76	74	69	17	" 29	9.7	5.4	9.2	6.7	3.9
9	Pride of Kansas	Samuel Wilson	Mechanicsville, Pa	98	83	90	9	" 29	8.4	4.2	9	7.2	4.3
10	" "	" "	" "	98	84	89	12	" 29	8.5	4.1	8.7	7	4.2
11	Farmers' favorite	Wm. H. Maule	Philadelphia	72	98	77	9	Oct. 11	9.8	5.2	9.2	6.9	4.2
12	Piasa queen	E. P. Kellenberger	Godfrey, Ill	100	97	97	3	" 4	10.1	5.7	9.7	7.2	4.2
13	Piasa king	" "	" "	90	95	91	12	" 4	10.2	5.5	8.6	7.3	4.2
14	Ivory dent	R. H. Vanderhoof	Newton, Ill	98	91	91	15	Sep. 29	9	5.4	8	7.2	4.2
15	" "	" "	" "	98	90	89	10	" 29	9.2	5	7.9	6.9	4
16	B. O. E. ensilage	J. H. Beagley	Sibley, Ill	....	85	75	7	" 21	8.3	3.5	7.9	6.3	4
17	Farmers' favorite golden	Peter Henderson & Co	New York	....	70	73	2	Oct. 11	11.1	5.8	9.4	7.2	4.2
18	Helms improved	Fred Helms	Belleville, Ill	100	95	88	8	" 11	10	5.4	9.2	6.5	3.7
19	White surprise	Henry A. Dreer	Philadelphia	94	72	83	13	" 11	10.5	6.1	9.1	8	5.2
20	" "	" "	"	94	75	77	18	" 11	9.7	5.5	9	7.9	4.9
21	Clark's 110-day	H. H. Clark	Onarga, Ill	100	86	81	4	Sep. 29	8.1	3.5	8	6.7	3.8
22	Burr's white	University farm	Champaign	90	83	79	1	" 29	8.4	3.7	8.5	6.6	3.7
23	Fisk's white	E. C. Fisk	Havana, Ill	98	86	83	6	Oct. 4	9.9	4.9	8.5	6.7	3.7
24	Murdock	Wm. T. Lamb	Ridott, Ill	98	90	91	11	Sep. 10	7.5	3	7.6	5.9	3.5
25	"	" "	" "	98	90	86	7	" 10	7.8	3	7.9	5.7	3.4
26	Leaming	T. Chester	Champaign	92	89	82	11	" 29	10.5	4.7	8.8	6.5	4
27	Boone county white	James Riley	Thorntown, Ind	92	95	90	12	" 29	10.1	5.3	8.1	6.8	4.1

28	Champion white pearl	Currie Bros	Milwaukee	98	86	79	9	"	29	8.7	4.1	8.5	6.7	4.1
29	Baker's white	G. W. L. Baker	Payson, Ill	94	93	91	12	"	10	8.2	3.2	8.5	5.8	3.2
30	" "	" "	" "	94	90	85	4	"	10	8.1	3.9	8.2	5.9	3.4
31	[White variety, no name]	J. W. Babb	Ashland, Ill	100	86	81	6	"	29	11.2	6.5	10.4	6.7	4.2
32	[Yellow variety, no name]	J. P. Shearer	Cullom, Ill	98	93	92	8	"	10	8.6	4.6	7.4	6.3	3.4
33	White prolific	Samuel Wilson	Mechanicsville, Pa.	94	89	87	8	"	21	7.7	3.7	7.9	6.2	3.7
34	Bickerdike's early mammoth	James Bickerdike	Griggsville, Ill	98	95	94	8	"	29	9.5	4.7	8	7	4.4
35	" " "	" "	" "	98	98	100	10	"	29	9.1	4.5	8.7	6.9	4.3
36	Farmers' interest	Geo. T. Leatherman	Burlington, W. Va.	100	97	97	3	"	21	8.7	4.1	7.2	5.9	3.3
37	Fisk's yellow	E. C. Fisk	Havana, Ill	98	93	89	6	"	21	7.7	3.2	8.2	6.7	3.7
38	Baker's yellow	G. W. L. Baker	Payson, Ill	100	98	92	7	"	29	8.9	5.2	7.9	6.5	3.4
39	Eclipse	E. P. Kellenberger	Godfrey, Ill	98	88	91	8	"	21	10.4	4.6	8	6.7	3.9
40	"	" "	" "	98	91	84	18	"	21	8.2	4.2	8.5	6.8	3.9
41	Early mastodon	Currie Bros	Milwaukee	74	60	55	8	"	21	8.3	3.7	9.3	7.2	4.5
42	Leaming	E. P. Kellenberger	Godfrey, Ill	100	98	....	....	"	21	8.3	3.7	7.8	6.2	3.7
43	Improved Leaming	John McCabe	Hammond, Ill	100	91	90	20	"	29	8.6	4.6	8.4	6.4	3.8
44	Sterling	J. T. Groves	Dana, Ill	96	91	90	8	"	21	9.1	4.6	8.3	6.7	3.8
45	"	" "	" "	96	92	90	19	"	21	8.2	4.4	8.6	6.7	3.8
46	Leeper	J. A. Leeper	Farmington, Ill	100	96	84	11	"	29	10.2	5	9.1	7.2	4.1
47	[Yellow variety, no name]	E. B. Watson	Waverly, Ill	100	98	95	8	"	29	9.1	4.6	8.4	6.6	3.8
48	" " "	S. P. Campbell	Loami, Ill	98	97	94	9	"	29	9	5.1	11	6	4.7
49	Clark's Iroquois	H. H. Clark	Onarga, Ill	100	89	88	8	"	21	9	4.7	8.2	6.8	3.7
50	" "	" "	" "	100	89	86	12	"	21	8.3	4.1	8.1	6.8	3.7
51	[Yellow variety, no name]	J. W. Babb	Ashland, Ill	98	96	91	20	"	29	9.5	4.4	9.2	6.5	4
52	Improved Leaming	Currie Bros	Milwaukee	96	85	82	5	"	21	9.4	5.3	8.4	6.8	4.1
53	Woodhull	Samuel Wilson	Mechanicsville, Pa.	86	86	82	14	"	29	8.6	3.7	10.9	6.6	4.4
54	Pride of Columbia	J. H. Beagley	Sibley, Ill	....	93	88	9	"	10	7.9	3.6	8.1	6.1	3.2
55	" "	" "	" "	....	94	92	12	"	10	8.2	4.5	8.1	6.1	3.1
56	Burr Oaks Leaming	" "	" "	....	89	92	8	"	21	9.2	4.2	8.2	6.9	4.2
57	Log cabin	C. N. Butt	Knoxville, Ill	98	93	90	12	"	29	8.2	3.5	8.7	7	4.3
58	Chester county mammoth	J. C. Vaughan	Chicago	90	77	75	15	"	21	8.5	4	7.7	7.4	4.2
59	California yellow	" "	"	94	86	98	12	"	29	8.8	4.6	8.2	6.8	3.7
60	" "	" "	"	94	83	81	9	"	29	7.6	3.7	8.2	6.7	3.7
61	Hughes	Agricultural Experiment Station	Columbus, Ohio	88	87	87	5	"	29	10.8	5.7	8.7	7	4.1
62	Thomas	" " "	Lincoln, Neb	86	89	89	7	"	10	8.2	4	8.6	6.7	4.2
63	Improved Leaming	S. S. Dunseth	Forrest, Ill	96	93	89	9	"	21	7.9	3.7	7.8	6.3	3.6
64	Clark's Onarga	H. H. Clark	Onarga, Ill	96	95	96	8	"	29	8.7	4.4	8.3	6.2	3.7
65	" "	" "	" "	96	92	84	11	"	29	9.2	4.5	8.4	6.5	3.5
66	Murdock	Wm. T. Lamb	Ridott, Ill	98	90	87	8	"	10	9.1	4.7	7.9	6.2	3.6

VARIETY OF CORN; SOURCE OF SEED; GERMINATION; STAND; BARREN STALKS; HEIGHT OF STALKS, OF EARS; SIZE OF EARS, OF COBS, 1892.

Plat.	Name of variety.	Source of seed received.		Percentage g'm'g in Geneva apparatus.	Percentage germinating in field.	Percentage of full stand of stalks.	Percentage of barren stalks.	Date of Ripening.	Height, ft.		Av. of 3 specimen ears.		
									Stalks.	Ears.	Length, in.	Circumference ear, in.	Circumference cob, in.
67	[Yellow variety, no name]......	Rufus K. Day................	Browningsville, Md.	92	93	89	9	" 29	8.7	4.4	8.2	7.7	4.8
68	Leaming.....................	University farm.............	Champaign.........	90	88	86	13	" 21	9.3	4.4	8.6	6.4	3.8
69	"	T. Chester..................	"	92	85	87	5	" 29	7.3	4.1	8.8	6.8	4.3
70	"	" "	"	92	93	94	8	" 29	8.3	3.7	8.6	6.9	4.2
71	Steward's improved...........	L. W. Steward...............	Amanda, Ohio......	100	96	92	6	" 29	10	5.5	7.7	6.6	3.7
72	Second premium...............	R. Q. Duncan................	Moweaqua, Ill......	90	86	85	1	" 29	8.7	4.5	8.4	6.7	3.7
73	Geo. Prentice corn............	Geo. Prentice................	Hallock, Ill.........	100	73	62	9	" 29	8.4	3.8	8.8	7.2	4.2
74	Branson's climax..............	W. T. Branson...............	Ipava, Ill..........	98	95	95	1	" 29	9.1	4.2	8.3	6.7	4.1
75	" "	" "	" "	98	81	95	6	" 29	8.8	4.4	7.6	6.7	3.9
76	Legal tender..................	Nims Bros...................	Emerson, Ia........	100	87	81	4	" 29	9.8	4.6	8.7	6.7	3.8
77	[Yellow variety, no name]......	James Riley.................	Thorntown, Ind.....	....	87	89	2	" 21	9.2	4.4	8	7	3.9
78	Riley's favorite...............	" "	" "	100	89	90	7	" 29	8.3	4.1	9	6.9	4.1
79	[Yellow variety, no name]......	W. C. Gibbs.................	Winchester, Ill......	98	96	91	12	" 29	9.2	4.3	8.6	7.1	4.2
80	" " "	" "	" "......	98	91	92	23	" 29	9.8	5.6	8.2	7.2	4.2
81	Calico.......................	S. M. Cox...................	Lacon, Ill..........	82	72	66	13	" 21	9.1	3.8	7.7	6.7	4
82	Cranberry....................	J. C. Vaughan...............	Chicago............	100	87	83	13	" 29	8.4	4.4	7.7	6.6	3.7
83	Hickory king..................	Samuel Wilson...............	Mechanicsville, Pa..	....	54	59	9	Oct 11	10.4	5	7.6	5.7	2.5
84	Clarage......................	Agricultural Experiment Station.	Columbus, Ohio.....	92	95	98	9	Sep. 21	8.7	4	8.1	6.4	4
85	"	" " "	" "	92	94	87	11	" 21	8.2	3.6	7.9	6.2	3.7
86	Callaway's white..............	S. H. Callaway..............	Orion, Ill..........	98	95	87	7	" 15	8.7	3.8	6.8	6.2	3.8
87	Ohio white dent...............	M. H. Smith & Son...........	DeSoto, Neb........	80	74	69	7	" 21	9.1	4.2	9.2	7.1	4.1
88	Hess white...................	Agricultural Experiment Station.	Columbus, Ohio.....	92	81	82	3	" 21	8.7	4.4	8.9	6.4	4
89	Blue River...................	J. Percival..................	Champaign.........	100	91	88	11	" 29	8.9	4.2	8.9	6.9	4.7
90	" "	" "	"	100	90	84	13	" 29	8.4	4	8.2	6.7	4.1
91	Champion white pearl..........	E. P. Kellenberger...........	Godfrey, Ill........	100	95	91	6	" 29	9.1	4.4	8.2	6.3	3.8
92	[White variety, no name]......	Wm. Sieck, Jr...............	Greenville, Ill.......	....	95	92	9	" 21	9.7	4.2	8.3	6	3.6
93	Kansas branching.............	W. E. Lodge.................	Monticello, Ill......	96	83	79	6	" 29	9.7	4.8	9.3	5.4	3.4

94	Early Wisconsin	Currie Bros	Milwaukee	94	86	75	8	"	10	7.9	3	8.2	6.3	3.7
95	" "	" "	"	94	86	73	12	"	10	7.2	2.6	8	6.2	3.9
96	Minnesota king	Samuel Wilson	Mechanicsville, Pa.	98	90	81	7	"	10	7.6	3.4	7.1	4.9	2.9
97	Early white dawn	A. W. Livingston's Sons	Columbus, Ohio	98	86	84	11	"	29	8.3	4.2	8.3	6.5	3.8
98	Beard's pearl	" " "	" "	100	85	74	4	"	21	8.7	4	7.7	6.7	4.1
99	Clarke county champion	J. M. McCullough's Sons	Cincinnati	100	90	83	6	"	21	8.8	3.2	8.6	5.7	3.3
100	" " "	" " "	"	100	86	89	7	"	21	8.1	3.6	8.2	6	3.6
101	Haber's early	K. B. Morehouse	Urbana, Ill	100	95	87	8	"	10	8.4	3.3	7	6	3.5
102	Pusey's cross bred	W. W. Pusey	Odell, Ill	....	92	81	20	"	5	7.9	2.6	9.5	5.8	3.7
103	Murdock	University farm	Champaign	96	84	85	5	"	15	8.6	4.6	8	5.7	3.6
104	Dunlap's white	H. M. Dunlap	Savoy, Ill	100	97	95	5	"	21	9.5	4.7	8.2	6.4	3.8
105	" "	" "	" "	100	95	94	8	"	21	7.7	3.4	7.4	6.4	3.7
106	Queen of the field	J. C. Vaughan	Chicago	100	93	71	6	"	21	8.2	3.8	7.2	5.9	3.2
107	Leaming	T. Chester	Champaign	92	92	94	7	"	29	9.7	4.3	9.1	6.7	4.3
108	Murdock	Wm. T. Lamb	Ridott, Ill	98	86	85	9	"	10	8.7	3.8	7.8	6.2	3.7
109	Edmonds	J. C. Vaughan	Chicago	92	82	81	4	"	21	8.3	3.6	7.4	6.2	3.4
110	"	" "	"	92	77	76	7	"	21	7.7	3.3	7.6	6.4	3.6
111	Early Butler	Currier Bros	Milwaukee	98	93	81	7	"	10	8.2	3.4	6.6	5.7	3.3
112	Munns	Jas. Riley	Thorntown, Ind	100	93	86	4	"	21	10.1	4.8	8.2	6.4	4.1
113	90-day yellow	J. W. Babb	Ashland, Ill	96	96	89	5	"	21	8.2	4.3	7.7	7.5	4.2
114	Pride of the north	J. C. Vaughan	Chicago	96	94	100	13	"	10	7.8	2.9	7.5	5.5	3.2
115	" " "	" "	"	96	93	86	6	"	10	7.2	3.1	7.6	6.2	3.3
116	[Yellow variety, no name]	E. P. Kellenberger	Godfrey, Ill	100	98	84	3	"	10	7.2	3	7.1	5.7	3.2
117	Burr's white-cranberry cross	Station, 1890		....	59	56	5	"	29	9.1	4.6	8.7	7.2	3.9
118	Burr's white-helms imp. cross	" "		....	92	91	7	"	29	8.7	3.9	9.4	6.5	4
119	Cloud's early	Henry A. Dreer	Philadelphia	72	62	57	15	"	29	8.1	3.7	8.5	5.9	3.4
120	" "	" "	"	72	69	61	12	"	29	8	4.2	8.9	7.3	4.6
121	Mixture, *a*			....	90	81	7	"	29	9.1	4.5	....	....	....
122	Mixture, *b*			....	87	83	7	"	10	8.6	3.8	7.9	6.4	3.7
123	Leaming-golden beauty cross	Station, 1890		....	92	100	4	"	29	9.3	4.8	....	....	....
124	Champion wh. pearl–Leaming cross	" "		....	69	75	11	"	21	8.5	4.2	....	....	....
125	Burr's white–Edmonds cross	" "		....	92	94	8	"	21	9.6	5.6	8.2	6.4	3.7
126	Mixture, *c*			....	88	85	5	"	29	9.2	4.6	8.4	6.6	3.9
127	Mixture, *d*			....	89	73	12	"	29	9.9	4.8	8.6	6.8	4.2
128	Mixture, *e*			....	99	86	19	"	29	10.8	5.7	9.7	7.3	4.2
129	Golden dew drop	Peter Henderson & Co	Philadelphia	96	97	....	....	"	5	5.8	1.7	7.7	4.3	2.6
130	Longfellow	Henry A. Dreer	Philadelphia	84	84	....	....	"	5	5.2	2.2	8	4.3	2.7

VARIETY TESTS, YIELD, 1892.

Plat.	Name of variety.	Per cent water in shelled corn when husked.	Lb. ear corn per acre when husked.	Lb. ear corn per bu. when shelled.	Lb. when husked to make bu. air-dry.	Bu. shelled corn per acre		
						Total as shelled.	Total air dry.	Loss in drying.
1	Murdock	22.2	4012	69.1	79	58.1	50.8	7.3
2	Ensilage corn	32.9	5750	71.8	95.2	80.1	60.4	19.7
3	[Yellow variety, no name]	20.6	5720	69.8	78.2	81.9	73.1	8.8
4	Leaming	17.5	3973	67.8	73.2	58.6	54.3	4.3
5	“	19.5	4440	66.3	73.4	66.9	60.5	6.4
6	Giant beauty	22.5	4280	69.5	79.8	61.6	53.7	8
7	Golden beauty	21.6	4740	68.4	77.7	69.3	61	8.3
8	Golden beauty	25.2	5380	69.5	82.6	77.4	65.1	12.3
9	Pride of Kansas	22.5	5130	69.9	80.3	73.4	63.9	9.5
10	“ “	24.5	5240	70.1	82.6	74.7	63.4	11.3
11	Farmers' favorite	30.1	5860	70.5	89.7	83.1	65.3	17.8
12	Piasa queen	27.5	8490	69.3	85.1	122.5	99.8	22.7
13	Piasa king	24.6	6540	69.5	82.1	94.1	79.7	14.4
14	Ivory dent	20.2	5530	67.9	75.8	81.4	72.9	8.5
15	“ “	19.9	6070	67.5	75	89.9	80.9	9
16	B. O. E. ensilage	26.6	5380	72.6	79.4	74.7	67.8	6.3
17	Farmers' favorite golden	29.4	6640	75.5	95.3	87.9	69.7	18.2
18	Helms improved	28.4	6860	69.7	86.6	98.4	79.2	19.2
19	White surprise	34.4	6460	76.5	103.8	84.4	62.2	22.2
20	“ “	36.6	6700	79.1	111.1	84.7	60.3	24.4
21	Clark's 110-day	23.2	4790	67.8	78.6	70.6	60.9	9.7
22	Burr's white	21.3	4900	67.5	76.3	72.6	64.2	8.4
23	Fisk's white	24.1	5690	70	82.2	81.2	69.2	12
24	Murdock	19.3	3690	68.1	75.2	54.2	49.1	5.1
25	“	18.9	4144	68.6	75.4	60.4	55	5.4
26	Leaming	18.6	4510	67.7	73.1	67.5	61.7	5.8
27	Boone county white	17.7	6310	68.2	73.8	92.5	85.5	7
28	Champion white pearl	16.5	4710	67.8	72.5	69.3	65	4.3
29	Baker's white	17.9	3640	64.4	69.8	56.5	52.1	4.4
30	“ “	18.7	4040	64.1	69.9	63	57.8	5.2
31	[White variety, no name]	23.7	6760	70.9	82.7	95.3	81.7	13.6
32	“ “ “ “	23	3920	68.2	79	57.4	49.6	7.8
33	White prolific	16.6	4710	68	72.5	69.3	64.9	4.4
34	Bickerdike's early mammoth	19.8	5310	70.3	78.1	75.5	68	7.5
35	“ “	23.7	6040	73.3	85.5	82.4	70.6	11.8
36	Farmers' interest	27	5320	66.3	80.8	80.2	65.8	14.4
37	Fisk's yellow	18.4	4380	66.8	72.9	65.6	60.1	5.5
38	Baker's yellow	19.6	4610	65.1	72.1	70.8	63.9	6.9
39	Eclipse	23.1	4720	68.5	79.3	68.9	59.5	9.4
40	“	25	4970	68.4	81	72.6	61.2	11.4
41	Early mastodon	23.8	4160	71.7	83.9	58	49.6	8.4
42	Leaming	25.7	5940	68.5	82	86.7	72.4	4.3
43	Improved Leaming	20.2	4668	69.3	77.3	67.4	60.4	7
44	Sterling	17.6	4860	68.3	73.8	71.1	65.8	5.3
45	“	17.3	5200	68.8	74.1	75.6	70.2	5.4
46	Leeper	19.9	4400	69.4	77.1	63.4	57.1	6.3
47	[Yellow variety, no name]	19.6	4830	66.6	73.9	72.3	65.3	7
48	“ “ “ “	18.7	5940	69.7	76.3	85.2	77.8	7.4
49	Clark's Iroquois	15.6	4820	65.1	68.6	74	70.2	3.8
50	“ “	15.8	5070	65.8	69.5	77.1	72.9	4.2
51	[Yellow variety, no name]	22.7	5060	67	77.1	75.5	65.6	9.9
52	Improved Leaming	16.5	4560	68.2	72.7	66.8	62.7	4.1
53	Woodhull	17.1	5770	67.6	76.9	72.2	67.2	5
54	Pride of Columbia	19.1	3660	64.6	71.2	56.6	51.4	5.2
55	“ “	18.7	4150	64.8	70.9	64	58.5	5.5
56	Burr Oaks Leaming	22.5	5110	70.2	80.6	72.8	63.4	9.4
57	Log cabin	17.8	5390	69.3	75.1	77.8	71.8	6
58	Chester county mammoth	18.2	5020	67.3	73.2	74.6	68.6	6
59	California yellow	16.8	4970	66.1	70.8	75.2	70.3	4.9
60	“ “	18.4	5540	66.9	72.9	82.8	75.9	6.9
61	Hughes	22.3	6530	71.3	81.7	91.6	79.9	11.7
62	Thomas	21.3	4940	69.2	78.3	71.3	63.1	8.2
63	Improved Leaming	15.9	5160	65.8	69.6	78.4	74.1	4.3
64	Clark's Onarga	18.1	5010	65	70.7	77.1	70.9	6.2
65	“ “	20	5680	66	73.4	86.1	77.4	8.7
66	Murdock	23.1	4800	67	77.7	71.6	61.8	9.8
67	[Yellow variety, no name]	19.1	6240	69.4	76.4	89.9	81.7	8.2
68	Leaming	16.4	5350	68.2	72.7	78.4	73.6	4.8
69	“	18.4	5610	68.9	75.2	81.4	74.6	6.8
70	“	19	5990	69.1	76	86.6	78.8	7.8
71	Steward's improved	22.8	5810	67.7	78.1	85.8	74.4	11.4
72	Second premium	17.6	5850	64.6	69.8	90.5	83.8	6.7
73	Geo. Prentice corn	21.9	4750	69.8	79.6	68.1	59.7	8.4

VARIETY TESTS, YIELD, 1892—*Continued.*

Plat.	Name of variety.	Per cent water in shelled corn when husked.	Lb. ear corn per acre when husked.	Lb. ear corn per bu. when shelled.	Lb. when husked to make bu. air-dry.	Bu. shelled corn per acre		
						Total as shelled.	Total air-dry.	Loss in drying.
74	Branson's climax..................	17.5	5490	66.6	71.9	82.4	76.4	6
75	" "	20.8	5820	66.8	75.1	87.1	77.5	9.6
76	Legal tender..................	21.8	4630	67.5	76.8	68.6	60.3	8.3
77	[Yellow variety, no name]..........	18	5760	68.7	74.6	83.8	77.2	6.6
78	Riley's favorite....................	17.5	5340	66.8	72.1	79.9	74.1	5.8
79	[Yellow variety, no name]..........	21.2	4470	68.1	75.5	65.6	59.2	6.4
80	" "	22.5	5870	68.1	78.2	86.2	75.1	11.1
81	Calico.............................	19.6	3690	69.2	76.7	53.3	48.1	5.2
82	Cranberry..........................	26.7	5020	67.1	81.5	74.8	61.6	13.2
83	Hickory king	30.1	3920	64.1	81.8	61.1	47.9	13.2
84	Clarage............................	18.7	4350	66.7	73.1	65.2	59.5	5.7
85	"	18.5	4640	66.6	72.8	69.6	63.7	5.9
86	Callaway's white...................	24.9	4700	73.4	87	64	54	10
87	Ohio white dent....................	21.4	5110	69.2	78.4	73.8	65.2	8.6
88	Hess white.......	19.2	5560	67.8	74.7	82	74.4	7.6
89	Blue River....................	19.8	5470	73.2	81.3	74.7	67.3	7.4
90	" "	19.8	5480	71.6	79.5	76.5	68.9	7.6
91	Champion white pearl.............	19.4	4570	68.3	75.4	66.9	60.6	6.3
92	[White variety, no name]	20.2	5750	67.1	74.8	85.7	76.8	8.9
93	Kansas branching..................	22	6060	71.8	81.9	84.4	74	10.4
94	Early Wisconsin...................	19.6	3960	69.2	76.7	57.2	51.6	5.6
95	" "	22.2	2740	69.5	79.6	39.4	34.4	5
96	Minnesota king....................	21.8	2920	71.5	81.3	40.8	35.9	4.9
97	Early white dawn.......	21.9	5070	68.6	78.2	73.9	64.8	9.1
98	Beard's pearl....	17.2	4020	68.1	73.2	59	54.9	4.1
99	Clarke county champion...........	20.9	4250	68.4	76.7	62.3	55.4	6.9
100	" " "	20.3	4860	67.6	75.5	71.9	64.4	7.5
101	Haber's early......................	25.7	3880	67.6	81	57.4	47.9	9.5
102	Pusey's cross-bred.................	22.2	3050	71.3	81.8	42.7	37.3	5.4
103	Murdock.	20.2	5050	68.2	76.1	74.1	66.4	7.7
104	Dunlap's white.....................	25.9	6020	68.6	83.8	87.6	71.8	15.8
105	" "	22.8	6600	67.1	77.4	98.3	85.2	13.1
106	Queen of the field.................	22.2	3390	70.3	80.5	48.2	42.1	6.1
107	Leaming......	20.1	6150	69.5	77.5	88.5	79.4	9.1
108	Murdock...........	21	4770	67.4	76.1	70.7	62.7	8
109	Edmonds	23.7	4470	67.6	78.9	66.1	56.7	9.4
110	"	23.4	4530	66.7	77.6	67.9	58.4	9.5
111	Early Butler........................	22.9	3590	68.7	79.4	52.2	45.2	7
112	Munns.	19.2	5650	68.9	75.9	82	74.4	7.6
113	90-day..............................	19.1	4640	67.6	74.5	68.6	62.3	6.3
114	Pride of the north....	17.8	3440	65.1	70.6	52.8	48.7	4.1
115	" "	16.9	3720	64.1	68.6	58	54.2	3.8
116	[Yellow variety, no name]..........	24.1	3740	67.8	79.4	55.2	47.1	8.1
117	Burr's white-cranberry cross........	24.3	5060	67.1	78.9	75.4	64.1	11.3
118	Burr's white-Helms imp. cross....	26.2	6260	71	85.6	88.2	73.1	15.1
119	Cloud's early.......................	24	4190	69.7	81.7	60.1	51.3	8.8
120	" "	24.9	5890	69.9	82.8	84.3	71.1	13.2
121	Mixture *a*.........................	22.4	5500	68.2	78.2	80.6	70.3	10.3
122	Mixture *b*......	17.1	4200	66.1	71.1	63.5	59.1	4.4
123	Leaming-Golden beauty cross.....	21.9	6660	67.7	77.3	98.3	86.2	12.1
124	Champion wh. pearl-Leaming cross	17.6	5770	70.1	75.7	82.3	76.2	6.1
125	Burr's white-Edmonds cross	20.3	5990	68.3	76.3	87.7	78.5	9.2
126	Mixture *c*.........................	21.5	4900	64.3	72.9	76.2	67.2	9
127	Mixture *d*.........................	23.8	4900	67.5	78.9	72.6	62.1	10.5
128	Mixture *e*.........................	24.4	7070	78.9	92.9	89.6	76.1	13.5
129	Golden dew drop..................	15	1100	68.9	78	15.9	14.1	1.8
130	Longfellow	14	670	68.4	71.2	9.8	9.4	.4

NUMBER OF EARS PER ACRE, AND WEIGHT OF 100 EARS, 1892.

Plat.	No. ears per acre.			Wt. 100 ears, lb.			Plat.	No. ears per acre.			Wt. 100 ears, lb.			Plat.	No. ears per acre.			Wt. 100 ears, lb.			Plat.	No. ears per acre.			Wt. 100 ears, lb.		
	Good ears.	Nubbins.	Total.	Good ears.	Nubbins.	Av. ears.		Good ears.	Nubbins.	Total.	Good ears.	Nubbins.	Av. ears.		Good ears.	Nubbins.	Total.	Good ears.	Nubbins.	Av. ears.		Good ears.	Nubbins.	Total.	Good ears.	Nubbins.	Av. ears.
1	4,557	6,123	10,680	55	23	37	34	6,121	2,079	8,200	75	37	65	67	6,838	3,482	10,320	73	38	61	100	7,379	3,181	10,560	53	27	46
2	4,160	4,160	8,320	86	57	67	35	5,225	6,295	11,520	71	39	52	68	5,159	5,281	10,440	61	32	51	101	3,541	6,139	9,680	58	28	40
3	5,250	4,750	10,000	71	41	57	36	3,895	7,425	11,320	65	35	48	69	6,545	1,575	8,120	78	44	69	102	4,849	3,271	8,120	44	20	38
4	3,914	2,846	6,760	72	33	58	37	4,217	5,783	10,000	63	35	44	70	6,342	4,498	10,840	67	34	55	103	7,564	2,636	10,200	58	17	49
5	4,604	3,836	8,440	65	35	52	38	3,041	7,719	10,760	57	31	43	61	6,069	4,371	10,440	70	39	56	104	7,373	1,407	8,800	79	44	68
6	3,554	3,046	6,600	82	44	65	39	6,194	1,606	7,800	70	32	61	72	7,105	3,495	10,600	66	35	55	105	7,235	4,085	11,320	65	40	55
7	5,173	2,587	7,760	75	40	61	40	5,509	4,131	9,640	65	30	52	73	4,248	4,112	8,360	77	37	57	106	3,976	5,664	9,640	53	26	34
8	4,920	3,360	8,280	76	40	65	41	3,982	2,738	6,720	78	36	62	74	6,313	2,367	8,680	73	43	63	107	5,949	3.931	9,880	74	34	62
9	5,496	2,264	7,760	79	40	66	42	5,784	5,416	11,200	70	40	53	75	6,196	5,164	11,360	64	32	51	108	6,600	3,840	10,440	54	26	45
10	5,139	4,021	9,160	79	40	57	43	4,444	4,716	9,160	57	27	51	76	4,921	4,119	9,040	67	33	51	109	6,062	1,698	7,760	68	27	58
11	5,236	3,044	8,280	85	44	71	44	4,994	3,046	8,010	69	47	60	77	6,200	3,720	9,920	73	38	58	110	5,763	3,277	9,040	55	28	50
12	7,537	3,263	10,800	90	43	78	45	4,259	5,221	9,480	87	28	55	78	4,986	5,214	10,200	59	34	52	111	5,016	4,264	9,280	50	28	39
13	4,763	5,477	10,240	74	41	64	46	5,471	4,169	9,640	63	34	46	79	5,167	2,953	8,120	81	45	67	112	7,410	2,430	9,840	67	29	57
14	5.687	2,473	8,160	79	46	68	47	4,694	5,266	9,960	58	34	48	80	5,305	4,295	9,600	76	39	61	113	5,943	4,457	10,400	56	30	45
15	5,237	5,123	10.360	70	42	59	48	5.978	5,022	11,000	66	36	54	81	5,577	2,183	7,760	61	33	48	114	6,245	2,475	8,720	43	26	39
16	5,096	4,704	9,800	79	36	55	49	4,777	3,703	8,480	68	39	57	82	4,031	5,169	9,200	68	42	55	115	7,431	2,849	10,280	42	22	36
17	4,438	3.642	8,080	74	51	82	50	4,493	5,707	10,200	65	38	50	83	4,158	2,922	7,080	59	37	55	116	5,231	5,929	11,160	47	23	31
18	5,935	4,945	10,880	77	41	63	51	6,164	3,596	9,760	58	36	52	84	6,106	2,374	8,480	60	37	58	117	4,883	2,197	7,080	81	39	71
19	4.275	2,565	6,840	110	61	94	52	4,076	5,124	9,200	66	36	49	85	5,865	4,575	10,440	54	31	44	118	6,448	4,552	11,000	76	36	57
20	3,980	3.980	7,960	114	65	84	53	5,861	3,419	9,280	63	31	56	86	4,192	6,288	10,480	65	33	45	119	4,279	1,681	5,960	93	41	70
21	4,605	4,835	9,440	66	39	51	54	6,183	2,217	8,400	50	20	43	87	6,634	2,166	8,800	78	41	58	120	5,307	2,533	7,840	85	38	75
22	5,266	4,694	9,960	65	38	49	55	6,333	4,507	10,840	48	22	38	88	6,676	3,004	9,680	60	35	57	121	6,971	2,949	9,920	68	49	55
23	4,897	5,143	10,040	71	45	57	56	4,433	5,367	9,800	64	32	52	89	5,160	2,520	7,680	75	27	71	122	4,604	5,076	9,680	53	36	43
24	5,502	2,458	7,960	59	29	46	57	6,079	3,881	9,960	57	32	54	90	6,434	3,886	10,320	65	33	53	123	8,294	3,226	11,520	64	36	58
25	6,207	3,913	10,120	56	28	41	58	4,137	4,783	8,920	72	38	56	91	4,736	5,344	10,080	58	37	45	124	6,289	2,471	8,760	79	37	65
26	4,953	4,127	9,080	80	37	49	59	5,922	2,278	8,200	69	41	61	92	6,987	4,413	11,400	63	35	50	125	7,269	3,131	10.400	63	38	58
27	5,476	4,564	10,040	70	36	61	60	4,629	5,731	10,360	71	31	54	93	7,956	5,684	13,640	53	27	44	126	6,220	3,340	9,560	63	36	51
28	4,349	5,291	9,640	63	34	49	61	5,228	4,532	9,760	73	49	67	94	6,115	2,085	8,200	56	28	48	127	6,336	2,904	9,240	65	31	53
29	5,115	3,925	9,040	52	24	40	62	4,851	3,949	8,800	63	31	56	95	2,966	4,154	7,120	52	21	38	128	6,031	3,769	9,800	83	44	72
30	7,013	3,507	10,520	47	22	38	63	4,646	6,194	10,840	60	35	48	96	3,824	5,616	9,440	43	27	31	129	3,286	2,714	6,000	26	11	18
31	6,898	3,262	10,160	78	41	62	64	6,990	2,330	9,320	61	32	54	97	5,444	4,356	9,800	69	37	52	130	2,736	2,224	4.960	36	11	13
32	3,510	6,770	10,280	55	28	38	65	7,624	3,336	10,960	60	32	52	98	4,218	5,102	9,320	62	31	43							
33	4,794	5,286	10,080	62	33	46	66	4,006	6,754	10,760	52	31	45	99	5,854	2,546	8,400	57	34	51							

queen, a yellow, late maturing variety, seed obtained from E. P. Kellenberger, Godfrey, Ill. It is rather too late for this locality.

The following table gives the yield for each of eight varieties for six years, and of eleven for five years, arranged in the order of the average yields. Of these varieties, Champion white pearl, Burr's white, and Helms improved are white; the others are yellow. Murdock and Edmonds are early maturing, Helms improved late, and the others medium. The average yield of the eleven varieties for five years is 69.3 bu. per acre. Other varieties of considerable merit, that have been tested for two or more years, are Dunlap's white, Clark's Onarga, California yellow, and ivory dent.

YIELD OF AIR-DRY CORN OF VARIETIES TESTED FOR YEARS NAMED.

Eight varieties tested in	1887.	1888.	1889.	1890.	1891.	1892.	Av.
Leaming	29.6	86.6	80.6	69.4	67.3	70.1	67.3
Champion white pearl	20.2	70	94.8	74.9	76.5	65	66.9
Burr's white	30	85.9	75.7	67.7	67.7	64.2	65.2
Steward's improved yellow	32.4	91.2	68.7	54.7	58.4	74.4	63.3
Riley's favorite	30.8	81.8	66.1	53.3	56.1	74.1	60.4
Murdock	33.3	80.3	65	61.6	59.8	57.6	59.6
Legal tender	25.8	84.2	68.9	60	56.8	60.3	59.3
Edmonds	27.7	83.7	66.3	55.9	58.6	58.4	58.4

Eleven varieties tested in	1888.	1889.	1890.	1891.	1892.	Av.
Champion white pearl	70	94.8	74.9	76.5	65	76.2
Leaming	86.6	80.6	69.4	67.3	70.1	74.8
Burr's white	85.9	75.7	67.7	67.7	64.2	72.2
Helms improved	84.8	102.6	51.1	39	79.2	71.3
Clark's Iroquois	68.5	81.9	59	65.4	72.9	69.5
Steward's improved yellow	91.2	68.7	54.7	58.4	74.4	69.5
Riley's favorite	83.7	66.3	55.9	58.6	74.1	67.7
Fisk's yellow	76.6	79.5	61.7	57.4	60.1	67.1
Legal tender	84.2	68.7	60	56.8	60.3	66
Murdock	80.3	65	61.6	59.8	57.6	64.9
Edmonds	81.1	66.1	53.3	56.1	58.4	63

A comparison of the white and yellow varieties for 1892 shows an average yield of 66.3 bu. per acre for the white and 66.2 bu. for the yellow.

Experiment No. 3. Corn, Time of Planting.

Experiments to test the effect of time of planting on yield have been conducted for the past five years. The ground used in 1892 was plowed about six inches deep in April, just after having been manured with barnyard manure at the rate of about thirty loads per acre. The plats, sixteen in number, were each two rods, or nine hills square, and were planted by hand, four kernels per hill, 3 ft. 8 in. apart each way. The first two plats were planted April 30th, and two plats were planted each week thereafter till June 20th. Two varieties of corn, Murdock (early yellow) and Burr's white (medium white), were used in each planting. One-half of the tract on which the Murdock was planted was in corn in 1891 and the remainder in oats. All the plats were cultivated three times and the weeds remaining were removed with a hoe. After the corn was well up and before the first cultivation, the number of plants on each plat was ascertained. Beginning with June 13th each stalk of one row running across each plat was measured each week during its growth. The average height in inches to the tip of tassel and upstretched leaf for each plat is given in the table for every week.

AVERAGE HEIGHTS TAKEN WEEKLY IN INCHES TO TIP OF TASSEL AND LEAF, 1892.

Plat.		June 13	June 21	June 29	July 4	July 12	July 19	July 26	Aug 2	Aug 9	Aug 17	Aug 23	Sept 6	Sept 21
1	Tassel..	....	....	....	....	....	85	95	96	95	93	93	95	....
	Leaf....	19	32	47	52	72	89	95	95	94	93	93	89	....
2	Tassel..	....	....	....	....	....	77	101	109	111	108	110	108	....
	Leaf....	19	32	48	54	73	86	101	108	107	105	106	103	....
3	Tassel..	....	....	....	....	....	77	99	98	98	98	98	97	....
	Leaf....	16	29	44	49	69	87	94	96	96	95	94	93	....
4	Tassel..	...	....	....	....	....	....	97	110	111	109	110	109	....
	Leaf....	14	28	40	51	63	75	93	108	110	110	108	106	....
5	Tassel..	....	....	....	....	....	70	92	97	96	96	96	96	....
	Leaf....	13	24	38	44	61	79	91	93	90	91	90	89	....
6	Tassel..	....	....	....	....	....	....	89	97	98	98	100	99	....
	Leaf....	12	20	33	37	55	72	90	98	100	99	99	99	....
7	Tassel..	....	....	....	....	....	58	86	91	91	91	90	90	....
	Leaf....	12	23	37	42	59	72	85	88	88	87	87	88	....
8	Tassel..	....	....	....	....	....	....	87	100	104	103	105	103	....
	Leaf....	11	23	3	42	57	74	93	96	104	102	104	102	....
9	Tassel..	....	....	....	....	....	....	66	80	87	87	88	87	....
	Leaf....	6	15	24	29	43	58	73	83	86	86	84	86	....
10	Tassel..	....	....	....	....	....	....	....	79	82	97	98	101	98
	Leaf....	7	15	23	28	41	54	70	85	93	94	96	98	98
11	Tassel..	....	....	....	....	....	....	64	69	86	91	90	88	....
	Leaf....	...	....	19	23	36	50	68	78	88	89	89	89	....
12	Tassel..	....	....	....	....	....	....	....	88	96	102	103	101	100
	Leaf....	....	....	21	27	40	56	76	88	99	103	104	102	99
13	Tassel..	....	....	....	....	....	....	....	86	84	94	99	101	101
	Leaf....	....	....	11	15	24	36	56	69	86	96	98	99	100
14	Tassel..	....	....	....	....	....	....	....	....	69	78	94	101	98
	Leaf....	....	....	8	11	18	30	47	61	73	87	95	98	98
15	Tassel..	....	....	....	....	....	....	....	....	68	78	89	93	99
	Leaf ...	....	....	....	7	15	26	42	54	67	81	88	90	97
16	Tassel..	....	....	....	....	....	....	....	....	....	67	82	86	86
	Leaf....	....	....	....	5	7	13	23	33	43	63	76	93	86

The first six plantings of Murdock and the first two of Burr's white were husked Oct. 6th; the remaining ones, Nov. 12th. When husked, the number and pounds of ears were ascertained for each third of each plat. The middle third was shelled, both corn and cobs weighed, and a jar of the shelled corn sent to the laboratory for the determination of water.

In the table it will be seen that there was a fairly good stand on all but the last planting. That so good a stand was procured for the first planting was probably due to the mean temperature, for a few days at that time, being nearly ten degrees warmer than the mean for the month of May.

The largest yield of air-dry corn, in the case of each variety, was from planting April 30th, the next from May 7th. Taking the average results of five years' trials, however, the largest yield, 66 bu. per acre, is from planting May 11th to 16th, with but one bushel decrease from May 4th to 23d.

Of the latest planting sixty per cent of the Murdock matured, but the Burr's white was all green. Of next to the last planting all the Murdock and twenty-five per cent of the Burr's white matured.

Murdock planted June 1st matured in 101 days, which is less time than any planted either earlier or later required, being 27 days less than that planted April 30th. From the table giving the weekly measurements it will be seen that the first four plantings of Murdock reached nearly their maximum height at the same date, July 26th, and that the first three plantings of Burr's white reached nearly their maximum height at the same date, Aug. 2d. This shows plainly the more rapid growth of corn planted later in the season when the ground is warmer, over that planted early when the ground is cold.

By very early planting, if a good stand is procured and the corn kept equally free from weeds, we may expect as large yields as from later planting. But for this locality the extra labor required to remove weeds and the risk of a poor stand will not justify planting earlier than about May 1st.

RESULTS WITH CORN FROM PLANTINGS AT DIFFERENT DATES, 1892.

Plat No.........	Name of variety.	Per cent that came up....	Date of planting.....	Date of ripening....	When husked.			Per cent water	Lb. ears when husked to make bu shelled.........	Lb. ears when husked to make bu. shelled air-dry.	Bu. per acre, air-dry
					No. ears per acre.......	Lb. ear corn per acre...	Bu. shelled corn per acre......				
1	Murdock..	85	Apr. 30	Sept. 5	10560	4200	63.6	15.36	66	69.4	60.5
3	"	81	May 7	" 5	9320	4280	63.9	17.27	67	72.5	59.4
5	"	79	May 16	" 10	9240	3840	57.1	16.04	67.2	71.2	53.9
7	"	88	May 23	" 10	10680	3970	58.4	17.48	67.9	73.4	54.1
9	"	79	June 1	" 10	8840	3630	52.7	20.48	68.9	77.1	47.1
11	"	82	June 8	" 21	10000	4660	66.6	24.43	70	82.5	56.5
13	"	81	" 13	" 29	9760	4250	62.1	20.82	68.4	77	55.2
15	"	72	" 20	Oct. 11*	6240	2300	28.7	35.42	80.1	82.8	20.8
2	Burrs white	83	Apr. 30	Sept 10	10480	6590	95.5	22.94	69	79.7	82.7
4	"	74	May 7	" 15	9840	6630	95.1	24.22	69.7	81.9	81
6	"	79	" 16	" 21	10200	6050	78.6	17.3	77	83	73
8	"	85	" 23	" 21	10400	5880	84.8	17.48	69.3	74.8	78.6
10	"	73	June 1	" 29	9360	5280	77.7	18.91	67.9	74.6	70.8
12	"	75	" 8	Oct. 4	9960	6090	89.2	21.4	68.3	77.3	78.8
14	"	71	" 13	" 11†	7560	3950	52.4	27.37	75 4	92.5	42.7
16	"	41	" 20	" 11‡	6240	2300	28.7	35 42	80.1	111	20.8

*60 per cent ripe. †25 per cent ripe. ‡Green.

RESULTS WITH CORN FROM PLANTINGS AT DIFFERENT DATES, 1888—1892.

Dates.	Bu. air-dry corn per acre.					
	1888.	1889.	1890.	1891.	1892.	Av.
April 22—25	......	52	......	51	......	51.5
April 27—May 2	80	44	67	50	71.6	63
May 4— 9	87	51	71	48	72	65
" 11—16	86	56	75	50	70	66
" 19—23	87	50	71	52	63	65
" 26—June 1	83	55	74	34	66	61
June 1— 8	81	50	61	37	59	59
June 8—13	50	50	60	19	68	46
" 20	.....	......	......	......	30.5	30.5

Experiment No. 4. Corn, Depth of Planting.

June 2, 1892, fourteen rows, each 4 rods in length, were planted with Burr's white corn, three kernels per hill. The hills were 3 ft. apart in the row, and the rows 3 ft. 8 in. apart. Rows 1 and 8 were planted 1 in. deep, 2 and 9, 2 in. deep, and so on, rows 7 and 14 being 7 inches deep. The land was adjacent to that used for experiment No. 5, and in every way treated the same. The number of hills and plants was greatest for the shallowest planting and least for the deepest. This experiment has been conducted for four years, and from the table it will be seen that the average number of ears per acre uniformly decreases from the shallowest to the deepest planting, and in general the average of bushels per acre also decreases.

RESULTS WITH CORN FROM PLANTINGS AT DIFFERENT DEPTHS.

Depth, in.	Ears per acre.					Bushels per acre.					Ears in a bushel.				
	1888.	1889.	1890.	1892.	Av.	1888.	1889	1890	1892	Av.	1888	1889	1890	1892	Av.
1	11,070	10,530	9,608	8,280	9,872	109 7	83	77.8	65.8	84.1	101	127	124	126	119
2	9,630	10,080	9,385	8,640	9,454	88.4	83	72.8	64.7	77.2	109	121	129	133	123
3	10,440	8,190	9,831	8,910	9,342	100.8	51	70.3	62.7	71.2	104	161	140	142	137
4	9,630	9,540	7,485	9,450	9,026	88	87	58.4	70.3	75.9	109	110	128	135	120
5	8,280	8,820	8,491	7,020	8,153	73.1	81	62.3	56.5	68.2	113	109	136	124	120
6	5,940	10,440	8,389	7,290	8,014	60.3	92	60.3	58.5	67.7	98	113	139	125	118
7	......	......	.....	5,130	.....	.....	....	.....	40.5	....	....	....	....	127	....

Experiment No. 5. Corn, Thickness of Planting.

The land used for this experiment was in oats in 1891, and was seeded to clover. It was plowed late in May, after the clover had made considerable growth and after having barnyard manure applied at the rate of about thirty loads per acre. June 4th Burr's white corn was planted by hand in each of 60 rows four rods long, at the varying number of kernels per hill and distances between hills shown in the table.

From the table it will be seen that the proportion of stalks harvested to kernels planted uniformly increases as the thickness of planting decreases. In general the ratio of ears to stalks increases as the thickness decreases. There seems to be no particular difference as regards the number of kernels per hill. The difference in yield being due to the number of plants on a given area. The weight both of stalks and ears increases as the thickness of planting decreases, except for the thinnest planting, when they are slightly lighter than for the next thicker planting. This would indicate that the maximum growth for each plant can be obtained when there is a goodly number, and that neither the size of ears nor stalks will be increased by having fewer plants than this number.

RESULTS WITH CORN FROM PLANTINGS AT DIFFERENT RATES OF THICKNESS, 1892.

Kernels in a hill.	Inches between hills.	Per acre.					Ratio of stalks harvested to kernels planted.	Av. wt.		Ears harvested to 100 stalks.	Bu. per acre, air-dry corn.				
		Kernels planted.	Stalks harvested.	Ears harvested.	Lb. stover.	Lb. ears.		100 stalks.	100 ears.		1888.	1889.	1890.	1892.	Average.
1	3	47520	23640	19200	9000	8430	.49	38	43	81	73	46.4	24.4	105.3	62.3
2	6	47520	23460	16980	9060	6735	.49	39	40	72	87.4	46.2	23.2	84.1	60.2
3	9	47520	23940	16260	9090	6960	.5	38	43	68	81.7	53.5	23.1	87	61.3
4	12	47520	23880	18840	9870	7815	.5	41	42	79	76.5	45.3	21.2	97.7	60.2
Av.	....	47520	23730	17820	9255	7760	.495	39	42	75	79.6	47.8	22.9	93.5	61
1	6	23760	13140	12660	6990	7275	.55	53	57	96	88.5	68.8	39.9	90.9	72
2	12	23760	14460	12960	8370	7890	.61	58	61	89	87.3	74	41.5	98.6	75.3
3	18	23760	15420	14340	8160	8265	.65	53	57	93	75.2	70.4	43.9	103.3	73.2
4	24	23760	14940	13200	8370	8070	.36	56	61	89	81.3	76.4	43.6	100.8	75.5
Av.	....	23760	14490	13290	7972	7875	.61	55	59	91.7	83	72.4	42.2	98.4	74
1	9	15840	9900	9540	8940	6975	.62	90	73	96	84.4	78.7	49.8	87.2	75
2	18	15840	11640	10260	7530	7155	.73	65	69	88	76	81.9	50.2	89.4	74.3
3	27	15840	10260	9120	7770	6600	.65	75	72	89	75.6	78.8	45.3	82.5	70.5
4	36	15840	9300	9420	7950	7165	.59	85	76	101	81.7	71.4	45.7	89.5	72
Av.	....	15840	10275	9585	8047	6973	.647	78.7	75	93.2	79.4	77.7	47.7	87.1	72.9
1	12	11880	9000	8160	8010	6405	.76	89	78	91	81.7	74.4	60.7	80	74.2
2	24	11880	9540	7380	9120	6090	.8	95	82	77	79.5	81.5	61.4	76.1	74.6
3	36	11880	8880	8280	8460	6930	.74	95	83	93	76	77.9	57.1	86.6	74.4
4	48	11880	9840	8400	9090	6885	.82	92	82	85	70.4	80.6	60.7	86	74.4
Av.	....	11880	9315	8055	8670	6577	.78	92.7	81	86.5	76.9	78.6	59.9	82.2	74.4
1	15	9504	8460	7440	8175	6015	.89	97	81	88	71.9	67.2	57.6	75.2	67.9
2	30	9504	8280	7860	7050	5790	.87	85	73	95	61.7	69.6	54.9	72.3	64.8
3	45	9504	8220	8220	7155	6030	.86	87	73	100	57.9	72.8	58.9	75.4	66.2
4	60	9504	7020	7020	5640	5790	.74	80	82	100	....	....	....	72.3	72.3
Av.	....	9504	7995	7635	7005	5906	.84	87	77	95.7	63.8	69.8	57.1	73.8	67.8

The yield of stover is greatest for the thickest rate of planting, but the bushels of corn is greater for thinner rates. Taking the average for four years, there seems to be but little difference between planting anywhere from 11,880 to 23,760 kernels per acre. If grown chiefly for the grain, the fewer the ears required to make the maximum yield the less the work in harvesting; but if much value is attached to the stover, the larger amount obtained by planting thicker might more than pay for the extra labor required to harvest the grain. If stover and corn are to be fed together, then it is pretty certainly better to plant thickly. This experiment would indicate that as corn is ordinarily planted there is much less danger of getting too many plants, than of getting too few. One chief reason why smaller yields are obtained from corn planted thickly is probably because many small ears are not husked.

In connection with the above there were planted in hills, on land only a few rods distant which had been cropped and treated the same, eight plats, the kernels per hill and distance apart each way being indicated in the table.

Three plats were planted with Murdock, seed grown at Champaign; three with Murdock, seed obtained from W. T. Lamb, Ridott, Stephenson, Co., in northern Illinois, to whom this variety was sent from the University farms some years ago; and two with Arleus, seed from C. Freeman, Princeton, Ill. Two of the three plats of Murdock from Champaign gave considerably larger yields than the corresponding ones planted with Murdock from northern Illinois.

The largest average yield was from planting five kernels every 3 ft. 8 in. each way, though a greater number of ears was harvested from planting four kernels every 3 ft. in the row and in rows 3 ft. 8 in. apart.

As stated in the report of *Experiment No. 1*, in 21 out of 24 cases larger yields of corn were obtained from plats planted with 4 kernels than from those planted with 3 kernels in each hill, all other conditions being as nearly alike as was possible to secure them.

RESULTS WITH MURDOCK AND ARLEUS PLANTED AT DIFFERENT RATES, 1892.

Plat.	Variety.	Distance between hills ft. and in.	Kernels per hill.	Number per acre.		Wt. of 100 ears in lb.	Yield per acre, bu
				Kernels planted.	Ears harvested.		
1	Murdock, Northern Illinois..	3-8 x 3-8	5	16970	10200	45.1	58.2
2	" Champaign.	" "	5	16970	11320	46.6	66.8
3	" Northern Illinois...	3-8 x 3	4	15840	11960	41.1	64.2
4	" Champaign........	" "	4	15840	10760	37.	57.3
5	" Northern Illinois...	" "	3	11880	7720	45.8	43.6
6	" Champaign........	" "	3	11880	9440	47.5	55 9
7	Arleus Princeton	" "	3	11880	7760	58.6	53.1
8	" "...............	" "	4	15840	9845	55.7	46.8

Experiment No. 6. Corn, Planting in Hills or Drills.

The land used consisted of five half acre plats. It was plowed in early May and planted May 26th to 28th with Burr's white corn. The corn was dropped by hand and covered with a hoe. The west half of each plat was planted four kernels per hill, 3 ft. 8 in. apart each way, and the east half, one kernel every 11 in. in rows 3 ft. 8 in. apart. The cultivation was the same on both parts, each being cultivated four times and the weeds remaining were removed with a hoe. Sept. 26th to Oct. 1st the corn was cut and shocked. In November the corn was husked and the yield ascertained. In March the stover was weighed. The accompanying table gives the yield per acre for each plat. It will be seen that there is but little difference in the yields of corn, three plats being very slightly in favor of drills and the other two in favor of hills, while the average is less than one bushel in favor of hills. In every instance the yield of stover is slightly in favor of drills, the average being 214 lb. per acre greater.

This experiment, like No. 5, both for this and previous years, seems to indicate that there is practically no difference between hills and drills, so far as yields are concerned.

RESULTS WITH CORN PLANTED IN HILLS AND DRILLS.

Plat No.	Yield per acre. (75 lbs. per bu).		Yield per acre lb. stover.	
	Hills.	Drills.	Hills.	Drills.
1	58.2	54.7	2520	2700
2	30.3	30.6	1440	1620
3	30.7	31.1	1340	1640
5	61.9	64.4	2600	2840
6	54.8	50.6	2552	2720
Av.	47.2	46.3	2090	2304

Experiment No. 8. Corn, Frequency of Cultivation.

June 3d the tract used for experiments No. 8, 9, and 10 was plowed, harrowed and planted with Burr's white corn, four kernels per hill, hills 3 ft. 8 in. apart each way. It was divided into ten plats. Plats 1 and 5 had the weeds removed without any cultivation and with the least possible disturbance of the soil; 2 and 7 were cultivated shallow, ordinary; 3 and 8 deep, ordinary; 4 and 9 shallow, frequent; and 6 and 10 deep, frequent. The scraping was done with a hoe. The shallow cultivation with the "Superior" cultivator, and a one horse "Planet Junior," the latter being used after the corn was too tall to be cultivated with two horses; and the deep cultivation with a one-horse double shovel. For the dates and frequency of cultivation see table. The number of ears and bushels per acre is given in the table for

RESULTS WITH CORN FROM SHALLOW AND DEEP CULTIVATED PLATS, 1892.

Kind of cultivation.	Yield per acre.		
	No ears.	Bu. corn	Av. bu. for 4 yrs.
None, weeds scraped from surface	9648.9	76.8	78.25
Ordinary, shallow (2 plats)	8404.9	70.1	78.82
Frequent, shallow "	9820.8	81.5	82
Ordinary, deep "	9839.4	80.1	75
Frequent, deep "	8897.7	69.2	73
Frequent, average (4 plats)	9359.2	75.3	77.6
Ordinary, " "	9122.1	75.1	76.9
Shallow, average (4 plats)	9112.8	75.8	80.4
Deep, " "	9368.5	74.6	74

each mode of cultivation. Frequent shallow cultivation increased the yield considerably this year, and gave a slight increase upon taking the average of four years. For deep cultivation the reverse is true. Taking the average of all frequent cultivation against the average of all ordinary cultiuation there is practically no difference in yield either for this year or for the average of four years.

CULTIVATION OF PLATS.

Date, 1892.	Plats 1 and 5.	Plats 2 and 7.	Plats 3 and 8.	Plats 4 and 9.	Plats 6 and 10.
June 27	Scraped	Shallow	Deep	Shallow	Deep
" 30				Shallow	Deep
July 6		Shallow		Shallow	
" 7	Scraped		Deep		Deep
" 14					Deep
" 15				Shallow	
" 20		Shallow	Deep	Shallow	Deep
" 22	Scraped	Hoed in row.	Hoed in row.	Hoed in row.	Hoed in row...
Aug. 4				Shallow	Deep

Experiment No. 9 — Corn, depth of Cultivation.

For care of crop, see report on *Experiment No. 8* (p. 197*)*. By consulting the table it will be seen that the smallest yield for 1892 was from frequent deep cultivation; while, contrary to former trials, ordinary deep cultivation gave a larger yield than ordinary shallow cultivation. The average of all plats, however, is slightly in favor of shallow cultivation, while the average of four years is in favor of shallow cultivation, both frequent and ordinary. Better yields are obtained by no cultivation, so long as the corn is kept free from weeds, than by deep cultivation. The average of four years shows an increase of 6.4 bu. per acre in favor of shallow cultivation over deep.

Experiment No. 10 — Corn, effect of Root-pruning.

Every other row of 18 rows running across the south end of the 10 plats used in *Experiments No. 8 and 9* was root-pruned four inches deep. The pruning was done three times — July 7th, 15th, and 28th—by placing a frame 12 inches square on the outside, over each hill, and drawing a guaged knife around the edge of it. When husked the number and pounds of ears for each row of each plat were ascertained. The table gives 90 weights, involving 45 comparisons. In 31 of these, the unpruned gave larger yields than the pruned. Taking the total yield of each row running across the ten plats, eight out of nine comparisons give the largest yield for the unpruned, and the sum of the pruned and unpruned is in favor of unpruned for each of the five sets of two plats.

The average yield per acre is 8.3 bu. greater for the unpruned rows.

These experiments and similar ones in previous years suggest that shallow culture is better than deep; that the injury to the roots, which necessarily results from deep culture, reduces the yield; that good crops may be secured in this soil without other cultivation than scraping the surface to destroy weeds, and that the gain from unusually frequent cultivation usually does not equal the extra cost of such cultivation.

RESULTS WITH CORN IN PRUNED AND UNPRUNED ROWS, 1892.

	Row.	Yield of ear corn, pounds.							
		Plats 1 & 5	Plats 2 & 7	Plats 3 & 8	Plats 4 & 9	Plats 6 & 10	Sum of ten plats.		Yield per acre bu. (75 lb.)
							No. ears.	Lb. ears.	
1	Unpruned	9.25	11.37	8.5	10.62	7.75	94	47.49	70.9
2	Pruned	6.25	8	9.87	7.75	9	82	40.87	61
3	Unpruned	11.5	13	10.75	11.25	10.5	94	57	85.1
4	Pruned	12.25	8.62	10.75	9.62	10.25	94	51.49	76.9
5	Unpruned	5.37	13.25	10.25	10	7.37	74	46.24	69
6	Pruned	7.5	12	11.25	12.37	6.12	90	49.24	73.5
7	Unpruned	10	9.37	11.12	12.75	10.62	90	53.86	80.4
8	Pruned	10.12	8.5	9.87	11	9.75	89	49.24	73.5
9	Unpruned	14	11.5	10.5	11.87	7.62	89	55.49	82.9
10	Pruned	9	8.12	8.75	13.37	8.25	81	47.49	70.9
11	Unpruned	10.5	11.75	11.75	11.5	8.25	87	53.75	80.3
12	Pruned	9.75	12.5	9.37	9.37	8.87	88	49.36	73.7
13	Unpruned	11.87	12.25	12.37	12.25	10.62	101	59.36	88.6
14	Pruned	7.25	8.12	9.37	11	7.25	76	42.99	64.2
15	Unpruned	10.87	9.75	8.62	10.37	9.87	83	49.48	73.9
16	Pruned	7.62	11.87	6.75	11.87	8.75	81	46.86	69.9
17	Unpruned	12.25	11.62	8.75	11	9.25	87	52.87	78.9
18	Pruned	8.62	10	10.5	10.75	8.75	78	48.62	72.6
	Total Unpruned	95.61	103.86	92.61	101.61	81.85	799	475.54	710
	Total Pruned	78.36	87.73	86.48	97.10	76.99	759	426.16	636.2

Experiment No. 89. Corn, Cross-fertilization.

In 1890 sixty-two ears were fertilized with pollen from other stalks, making thirty direct crosses. The cross-fertilization was effected by covering the shoots as soon as they appeared with small cloth bags, and the tassels from which pollen was wanted with either cloth or paper bags. When the silks had become from two to six inches long, the covering was removed and the pollen, from the desired variety, was applied and the ear again covered. An umbrella was used during the process to shield the silk from pollen falling from the surrounding stalks. In most cases the ears were fairly well filled though some of the cobs were only partially covered with kernels.

In 1892 a small plat was planted from each of 50 of the above ears. Three shoots of each plat were covered and fertilized as were the above. One shoot was fertilized with pollen from its own tassel (self-fertilized) and the other two with pollen of other stalks always from the same plat. The time of ripening and the number and pounds of ears were ascertained for each plat, the artificially fertilized ears marked and a record made of them. The immediate result of a cross often showed little or no evidence of the cross; the product of the immediate result planted usually showed such evidence, the ears varying widely. The ears of the cross-bred corn were frequently larger than the average of the parents and the yield, as shown in *Experiment No. 1*, p. 179, was increased by crossing.

Experiment No. 90. Growth of the Corn Plant; Increase of its Dry Matter.

For four years the rate of growth and the increase of the dry matter in the corn plant have been carefully studied. For three years the composition of the plant has been determined at weekly intervals.

In each year the results have shown a steady increase in the quantity of dry matter until the plant has become fairly mature. In no year has there been more than half the total quantity of dry matter when the plant has reach its full height and not more than 75 per cent of the maximum when the ears were in the soft dough stage. In several cases there has been a slight decrease in the quantity of dry matter as the plant became fully mature. This may be explained by the dropping of leaves or tassels. Aside from this, the evidence seems conclusive that the greatest quantity of dry matter can be secured by not cutting the crop until it is fully ripe. The total weight is greater at an earlier stage because of the greater per cent and quantity of water. In 1892 the plants showed about 90 per cent of water for several weeks while young, and did not fall below 75 per cent of water until Sept. 1st. The lowest percentage found was 56 at the last examination, Oct. 7th.

The rapid growth of the corn plant under favorable conditions has been well illustrated. An increase of 48 inches in height in two weeks has been observed in varieties not especially tall growing. In 1892 a growth of 28 inches was noted in one week.

The chemical analyses, made under direction of Mr. Farrington, chemist of the Station, show that, while there has been a fairly uniform increase in the weight of the ash, protein, fiber, nitrogen free extract, and the fat or ether extract up to the date when the corn was fairly well matured, the composition of the dry matter shows a steady decrease in the percentage of ash and protein; at first there is an increase and then a decrease in the percentage of fiber; a steady increase in the percentage of nitrogen free extract, and a good deal of variation in the percentage of ether extract with, in general, a considerable decrease until the plant becomes nearly mature.

Aside from questions of digestion and palatability, these observations, as well as trials on a larger scale, suggest the belief that cutting the corn crop before it has become reasonably mature involves a considerable loss.

Experiment No. 134. Corn, Effect of Removing Tassels.

The tassels on every other row of ten rows of Burr's white corn were removed as soon as they appeared, many of them being removed before they had emerged from the leaves. Of another ten rows the tassels on every other row were removed after they were fully out, but before they began to shed pollen.

The following shows no differences that can be attributed to removal of the tassels. The yield when tassels were removed early was slightly decreased, while removing them when well out slightly increased the yield. The total difference between removing and not removing is 10.5 lb. in favor of not removing. This is essentially the same as for 1891, when there was only one lb. difference in yield between 15 rows having no tassels and 15 having them left on:

Results with Corn from Removing Tassels in Part, 1892.

No. Rows.	Tassel.	No. ears.	Lb. ears.	Wt. 100 ears.
5	Removed early	417	228	54.7
5	Left on	432	242	56
5	Removed when out	415	232.5	56
5	Left on	422	229	54.3
10	Removed	832	460.5	55.4
10	Left on	854	471	55.2

GENERAL CONCLUSIONS.

Indian corn is the most important grain crop of Illinois. From 5,000,000 to 7,000,000 acres are annually planted to corn each year by Illinois farmers. A small increase in the yield per acre would mean an increase of some millions of dollars in the total value of the crop in the state. The uniform results of the experiments at this Station for five years past indicate that an increase of at least five bushels per acre over average yields may be secured without increase in cost of producing the crop.

There are many good varieties grown in the state. There seems to be no good reason for sending to a distance for new varieties. The claims made by many seedsmen concerning the superiority of varieties offered by them are gross exaggerations. But there are marked differences in the value of different varieties. For central Illinois, probably for northern Illinois, but less certainly for southern Illinois, it is wise to select a variety with as large ears, if well shaped, as practicable, provided the time of maturity is early enough to reduce danger from frosts in the autumn to a minimum. Neither yield nor feeding value depends on the color of the kernels, or on the smoothness or roughness of the ears.

For the soil and climate at the Station grounds varieties are preferred which have stalks eight to ten feet high, of medium thickness, with short joints and abundant foliage; producing ears at a height of from three feet six inches to four feet; the ears having short shanks. It is preferred that the ears be from eight to ten inches in length, and about two and one-half inches in diameter; nearly uniform in diameter except near the tips; well filled at both ends; with from 16 to 20 rows; the kernels thick rather than thin, somewhat wedge shaped and with little space between the rows. The cob may be from one to one and a quarter inches in diameter.

Some excellent varieties vary from this description in a marked degree in one or more particulars. No one variety has been found which possesses all good qualities. Varieties with remarkably large ears mature too late; very early maturing varieties do not give large yields, nor do those with exceptionally small cobs.

Several experiments make it seem probable that cross-breeding corn will usually increase the yield. It is undetermined how long the improvement may continue.

While the varieties classed as early maturing do not give so large crops as the medium maturing ones, it is often profitable to plant a few acres with such varieties for use in the early autumn, as it is believed that the greater palatability of the new crop corn more than counterbalances the loss from lessened quantity.

The results of many trials suggest that most farmers in central Illinois have attached undue importance to early planting and frequent cultivation, and have done harm by too deep cultivation especially after the corn has made a fair growth; and that they have attached quite too little importance to securing a uniform stand, with at least 12,000 stalks per acre. At the Station good yields have been secured from planting any time in May, and corn planted at a comparatively late date has required less cultivation to keep the ground free from weeds. A good condition of the soil at the time of planting is more important than early planting. Thick planting reduces the size of the ears; but larger yields have been secured in many trials where the number of stalks was at the rate of one kernel each nine inches in rows three feet eight inches apart than from a thinner stand. Little or no gain has been observed from planting in drills compared with planting in hills, with equal numbers of stalks per acre. While "thinning corn" is a troublesome process it is probable its cost would often be abundantly repaid

The weight and good quality of the stover are increased by rather thick planting.

At the Station weeds are the chief enemy of the corn crop. The soil is loose enough to permit ready access to roots, water, and air. Deep plowing, as a rule, does not increase the yield. Deep cultivation of the corn has done harm generally. Unusually frequent cultivation has not been profitable. That method of cultivation seems best which most cheaply prevents the growth of weeds and leaves the surface of the ground comparatively level and smooth, with the least possible interference with the roots.

In a degree greater than the appearance of the plant would indicate, the percentage of solid matter in the corn plant is small during the early period of growth. Both the percentage and the actual quantity of solid matter, and probably the food value of the plant increase until it is nearly or quite mature. It may be profitable in many cases to cut and feed the crop before the kernels have fairly hardened, but there is always a loss of possible value when this is done. The obvious danger of loss from storms and by the dropping of leaves, if the corn is left until fully ripe before it is cut is a sufficient reason for moderately early cutting; but the evidence seems conclusive that much corn is cut when too immature, and this whether it is to be put in a silo or fed as dried fodder.

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All communications intended for the Station should be addressed, not to any person, but to the

AGRICULTURAL EXPERIMENT STATION, CHAMPAIGN, ILLINOIS.

The bulletins of the Experiment Station will be sent free of all charges to persons interested in farming who may request that they be sent.

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UNIVERSITY OF ILLINOIS,

Agricultural Experiment Station.

CHAMPAIGN, MAY, 1893.

BULLETIN NO. 26.

THE FOREST TREE PLANTATION.

PRELIMINARY HISTORY.

The first official act in the establishment of this experiment was the report made to the Board of Trustees of the University by its Committee on Horticulture, November 18, 1868. The members of the committee were Burden Pullen, Samuel Edwards, O. B. Galusha, M. L. Dunlap, and W. C. Flagg. The following is taken from the report:

> The great feature of these horticultural grounds, and what is of paramount importance at this time to the whole people of the state, is the planting of forest trees for useful purposes. It is a new demand upon their industry and upon their lands, from which they cannot fail to reap the most valuable results.
>
> The new condition of things created by railroads and improved agricultural implements presents new industries, both to the cultivators of the soil and to the mechanic, in which they have a mutual interest. The forests are rapidly disappearing, or at least those useful trees that have a commercial value, and yet many of the new demands have not been met nor is the old supply likely to hold out. But if the forests of Michigan, Wisconsin, Minnesota, and Indiana were adequate to the demand, as a matter of economy in freights, if not in the superior quality of our second growth timber, especially of the deciduous varieties, it is an object to grow them at home rather than to buy them.
>
> Timber for railroad ties, culverts, cars, roadways, and buildings, fencing, vineyard stakes, hop poles, stanchions for coal banks; soft wood, like white willow and the poplars, for berry boxes, crates, and staves; hoop poles, carriage and wagon material, agricultural implements, and the multiform wants of the age, make up a demand of most surprising magnitude, that will add to our rural industry an importance that the most sanguine have not heretofore dreamed of.
>
> If we look at this as simply the demand of agriculture, it must be conceded that it is legitimate and ought to be granted without an objection; but we have added to this the claim of the mechanic, who is also largely interested, for it will enable him to compete with those of other states in the supply that commerce demands.
>
> The state that sells the raw products of its soil is never rich, while the states that manufacture for others do well; those that grow the raw material and manufacture it at home are the most prosperous. No doubt the State of Illinois had these facts in view when it established this great school of the industries for the especial benefit of those two classes who create the wealth of the state.
>
> There are in this state about eighty species of forest trees, besides the larger shrubs. With the exception of the oaks, yellow poplar, and hickory, we have not drawn largely from our native forests, and to-day we purchase nearly all of our

timber. Nearly all of the ash timber used for agricultural implements, a part of our fence posts, and a portion of our railroad ties come from other states. Added to these are the greater part of the material for our wagons and carriages, when not wholly manufactured in other states; the timber for railroad cars, and the hardwood lumber for many other useful purposes, that ought to be grown near the place of manufacture.

To bring these useful trees within the bounds of culture and to utilize them is one of the objects of this industrial institution. To teach the people of the state how to add these products of the forest to their other crops, and thus add millions of dollars annually to the wealth of the state, to give labor a wider range and a more comprehensive field for its employment, are objects worthy of such an institution.

Thousands of acres of timber can be planted in shelter belts, to check the winds that come down from the north, with its polar cold, destroying the plants that the genial summer, fanned with the breath of the tropics, has made to flourish on our open plains. Wall in these prairies of central and northern Illinois with belts of conifers and deciduous trees, and we shall have one of the best of climates, genial and equable; and with the best soil in the Union, with a geographical position midway between the two oceans, over which must pass a large part of the commerce of the world, if we are not laggards in the world's progress we may reap from such surroundings a rich reward.

The committee has divided these thirty species of useful forest trees into three classes, according to their supposed value for the demands of commerce and for domestic use. In the first class they include the European larch, Austrian pine and Norway spruce, native trees of Europe, and the osage orange, native of the southwestern states. In the second and third classes white willow, a native of Europe; black spruce and Norway pine, natives of the more northern states. Thus making up the list with four European, three of other states, and twenty-three species from the forests of Illinois.

Our other native trees of minor importance will find a place in the arboretum, where those of other sections of this continent and of Europe may be tested side by side. It is probable that among them may be found many of value.

First Class. European larch, osage orange, white pine, white ash, Austrian pine, green ash, arborvitæ, blue ash, red cedar, Norway spruce.

Second Class. White sugar maple, black sugar maple, American chestnut, shellbark hickory, cucumber, Norway pine, silver leaf maple, tulip, white willow, black walnut.

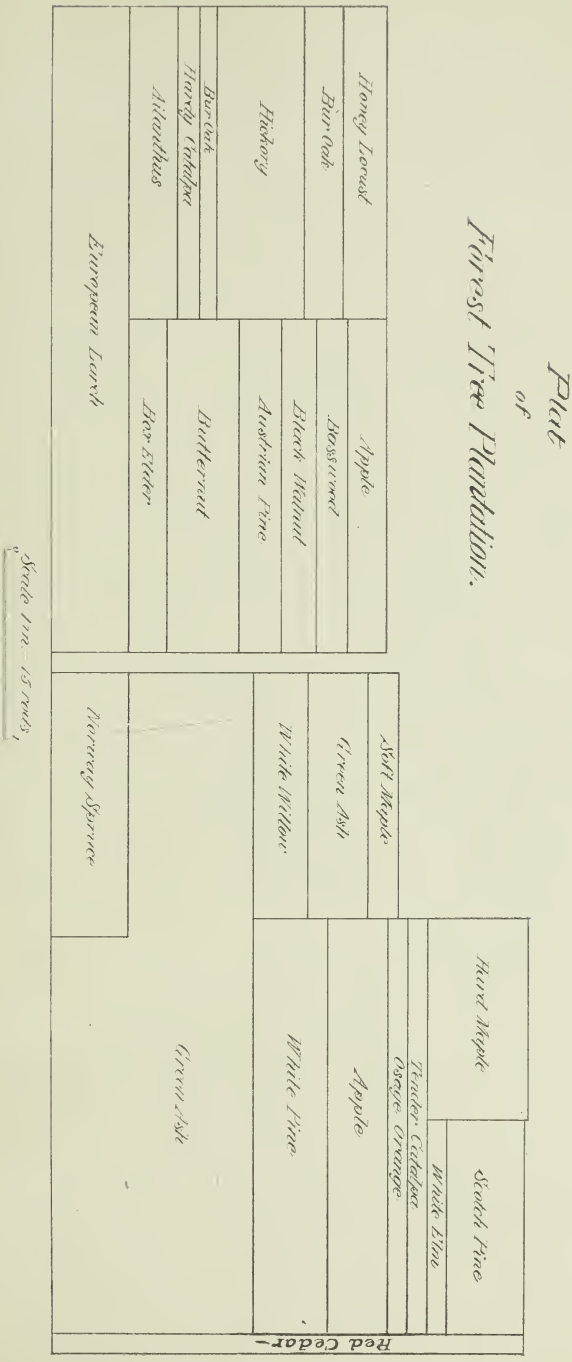
Third Class. Red maple, white elm, red elm, butternut, catalpa, hemlock, basswood, white oak, black spruce, bur oak.

The white pine, Austrian pine, Norway spruce and hemlock to be planted eight by eight feet: all others four by four feet. The former requiring six hundred and eighty trees to the acre, and the latter two thousand, seven hundred and twenty. The above distances to be varied to some extent by way of experiment, to ascertain, by actual trial, the most proper distances for the planting of the several species.

In accordance with this report an appropriation was obtained from the state legislature, from which $1,000 was set apart, March 11th, 1869, for trees and seeds.

LOCATION OF PLANTATION AND CHARACTER OF SOIL.

The experimental forest tree plantation of the University was begun in the spring of 1871; since then additional plantings have been made from time to time. It is located upon the east end of what is known as the experiment farm, and at present comprises about thirteen acres planted. The land was originally prairie, but had been under cultivation for thirty or more years, mostly in corn. A part, however, had been too wet for tillage, and was used for pasture or meadow. Through this portion, before the trees were set, an open ditch was dug, which rendered the ground sufficiently dry for planting. The soil is the black loam common to the prairies of central Illinois, but varies a good deal as to richness in different parts. On the highest portions the wash of many years and the continual cropping without fertilization in any


Plat
of
Forest Tree Plantation.
Honey Locust
Bur Oak
Hickory
Bur Oak
Hardy Catalpa
Ailanthus
European Larch
Apple
Basswood
Black Walnut
Austrian Pine
Butternut
Box Elder
Scale 1 in. = 15 rods.
Soft Maple
Green Ash
White Willow
Norway Spruce
Hard Maple
Scotch Pine
White Elm
Tender Catalpa
Osage Orange
Apple
White Pine
Green Ash
Red Cedar

way had left the soil so poor that the common farm crops failed to be remunerative; while some of the lower parts have a deep vegetable loam overlying tenacious clay. In no case, however, has manure been applied —probably none had ever been applied—to any portion of the land upon which the plantation exists. As far as practicable, advantage was taken of this diversity of soil and location in planting, so as to suit the requirements of the several kinds of trees. The tract is one hundred and six rods long from north to south. The rows of trees run north and south. An east and west roadway divides the plantation into two equal portions.

VARIETIES OF TREES.

The kinds of trees originally selected were such as were esteemed of special value or importance, but owing to various causes the list as first made has not been completely filled, while a few other kinds have been added. The following species of trees have been planted. The names are those of Gray's Manual.

Basswood (*Tilia Americana*).
Tree of heaven or ailanthus (*Ailanthus glandulosus*).
White, silver, or soft maple (*Acer dasycarpum*).
Sugar, rock, or hard maple (*Acer saccharinum*).
Box elder or ash leaved maple (*Negundo aceroides*).
Three thorned accacia or honey locust (*Gleditschia triacanthos*).
Hardy catalpa (*Catalpa speciosa*).
Tender catalpa (*Catalpa bignonioides*).
Green ash (*Fraxinus viridis*).
American or white elm (*Ulmus Americana*).
Osage orange (*Maclura aurantica*).
Butternut or white walnut (*Juglans cinerea*).
Black walnut (*Juglans nigra*).
Shell-bark or shag-bark hickory (*Carya alba*).
Big shell-bark or king nut (*Carya sulcata*).
Bur oak, over cup, or mossy cup (*Quercus macrocarpa*).
Chestnut (*Castanea vesca*).
White willow (*Salix alba*).
White pine (*Pinus strobus*).
Austrian pine (*Pinus Austriaca*).
Scotch pine (*Pinus sylvestris*).
Norway spruce (*Abies excelsa*).
European larch (*Larix Europaea*).
Red cedar (*Juniperus Virginiana*).

METHOD OF PLANTING.

Most of the trees were purchased as seedlings, one to three years old, of various nurserymen, and were placed in the nursery for about two years. The larch were planted directly in the forest when one year old, and the first chestnuts at two years. The catalpa, butternut, black walnut and bur oak were grown in nursery from seed, the white willow from cuttings, while the box elder, chestnut second planting, and the two hickories were planted as seed directly in the forest. In this latter way were also planted white oak and pecans, both of which failed—the former mainly from the depredations of rabbits and mice digging and eating the acorns, the latter by being plowed up by a careless employé. These have not been replanted. The ailanthus, honey locust, and linden were transferred from the nursery when about six to eight feet high.

Later some apple were planted when four or five years from the root-graft. All of the early planting was done in rows four feet apart, and with the exception of Scotch, Austrian and white pine, two feet in the row. At this time it was strongly argued that the trees would make a more upright growth if planted very close, and that the trimmings from time to time would be a source of profit. The later plantings, however, including the hardy catalpa, linden, ailanthus, honey locust, oak, and the transplanted hickory, were made in rows eight feet apart, and with the trees usually four feet apart. The method of planting for all small trees was as follows:

The ground being put in good condition by plowing, harrowing, and the use of a plank "clod-crusher," a line was stretched the length of the proposed row, when by walking upon the line a straight mark was made, sufficiently distinct for the purpose, after the line was removed. Two men went together, one with a spade or shovel, the other with an armful or basketful of seedling trees. Guided by the mark the former raised a shovelful of earth, the latter put into position a young tree; the earth held upon the shovel for the purpose was now thrown on the roots, and was tramped down by the man carrying the trees. In this expeditious way the work was done well, and at comparatively little cost. The planting of the larger trees was neccessarily attended with much more labor, in excavating a sufficiently large and deep hole, in digging and distributing the trees, and in more carefully filling around the roots, while the result with the small stock ordinarily proved more satisfactory.

The seeds of the box elder, oaks, chestnut, and hickories mentioned above, were planted in the autumn as soon as gathered; otherwise the planting was all done in the spring, and as early as possible. As stated, the chestnuts and acorns were destroyed by rabbits and mice; otherwise the fall-planted seeds did excellently well.

Cultivation, Trimming, and Thinning.

The young trees were cultivated during several summers, usually about five, just as corn is worked. While the trees were small enough, two-horse corn cultivators were used, after which one-horse double-shovel plows. For the first two seasons the rows were also hoed out about twice each year. Some of the later plantings were not so well cultivated, with sufficient indications of the fact in the less satisfactory results.

As soon as the trees shaded the ground, so as to keep down an injurious growth of weeds, cultivation was discontinued; after this very little expense was involved in the management of the plantation.

Up to the year 1888 there was but little trimming except such as always comes naturally to thickly grown trees. The branches of all deciduous trees soon decay and fall off, and this has given most of the older trees clean trunks ranging from ten to thirty feet. In most of the pine and pine-like trees the dead branches, being full of resin, remain for a long time, and, as the tree grows around them, they make loose knots in the timber.

In the winter of 1888-9, the white, Austrian, and Scotch pine trees were trimmed up to a height of about ten feet, though not all the dead wood was taken off. The branches of the white pines are dead now to a height of twenty to twenty-five feet, in some cases more. The Scotch and Austrian pine branches have not died so high. During February of the present year the Norway spruce and European larch have been trimmed; the spruce to the height of about eight feet and the larch to ten or more. The spruce were trimmed as high as all the branches were dead; but the larch have but few live branches until a height of twenty feet or more is reached.

From time to time the rows were thinned so that the remaining trees stood four to six or eight feet apart, and after about seven years alternate rows were cut out from the ash, Norway spruce, larch, butternut, black waluut, soft maple, osage orange, tender catalpa, and elm. The remaining rows were further thinned, in some cases as the trees were required to be set out on the University grounds, or for use on the farm, as posts, etc.; or in the case of the pines, as the trees died. Some of the trees have been trimmed up—the lower branches being cut away so as to leave a clean trunk several feet high; but by far the greater number have been left to trim themselves.

MISTAKES IN VARIETIES.

In the spring of 1869 there were purchased 3,000 seedlings of green ash, and special pains was taken by the committee to secure a lot of white ash. The search for seedlings of the latter caused a delay of one year, when 20,000 seedlings, believed to be of this species (*Fraxinus Americana*) were secured.

It certainly requires the knowledge and acuteness of an expert to identify this species in the seedling state; though the seeds themselves and the matured trees are quite readily recognized. The second lot of seedlings was green ash, though named in the reports for several years as white ash. It may be well to state also that an attempt followed to get genuine white ash seed; an order was made on one of the best nurserymen in the country for a sufficient amount of seed to furnish the required seedlings. This seed upon arrival was pronounced green ash again, but the dealer being confident to the contrary, some of it was planted and green ash seedlings appeared. Once more true white ash seed was gathered, but for some reason, probably because allowed to become too dry, only a small proportion germinated. No white ash has yet been planted in the forest. The mistake here made is a very common one in the country generally, and is productive, as in this case, of serious consequences. It is the more to be regretted because of the easy identification of the seed of the several species of ash; no nurseryman need blunder in planting.

In a similar way 10,000 seedlings of "black" sugar maple (*Acer nigrum*) were purchased of one nurseryman and a like quantity of "white" sugar maple (*Acer saccharinum*) of another. Both proved to be the latter. In this case, however, the distinctions are not so pronounced. Botanists now usually make the former a variety only of the latter, the recognized difference not being deemed sufficient for specific distinction. Furthermore there is little difference in the trees for timber purposes.

When this plantation was commenced, attention had not been called to the fact that there were two kinds of catalpa, differing from each other in very important particulars for the purpose of timber-growing as well as other uses; but two species are now recognized: *C. speciosa*, the hardy western type, and *C. bignonioides*, the tender or south-eastern type. Unfortunately the latter was used in our first planting. Indeed, the true western type of this tree, indigenous in the Mississippi Valley, though so much better than the eastern variety, was rarely seen in cultivation even in western localities until within the last fifteen years. We now know that the two kinds are easily distinguishable, and as the seeds are sufficiently unlike, no further mistake should be made. As the records will show, the two kinds give very different results in the plantation.

Differences in Varieties.

In this connection mention should be made of the difference in *varieties* of many species of timber trees and of the capital importance of attention to these differences in selections for practical arboriculture. The white elm (*Ulmus Americana)* varies so much that woodsmen have several special names for the kinds, of which some are very valuable for certain uses, while others are worthless. The same may be said of box elder, tulip poplar (*Liriodendron tulipifera*), and cottonwood. Some differences are due to soil and situation (a thing also worthy of study), but the seed of certain trees gives very different stock from that of certain other trees of the same species; sometimes the varieties grow mixed together in the same region of country, sometimes the distinctions are seen only in trees geographically separated. The so-called yellow cottonwood of the Mississippi Valley, the wood of which is readily split and worked, is specifically identical with the almost worthless common cottonwood (*Populus monilifera*) of our part of the country.

History of the Plantation.

As a further contribution to the history of the plantation, extracts from some of the annual reports are here appended, together with tables taken from the same. It is interesting to note the estimation placed upon the results at the times reported:

FOREST RECORD FOR 1871.

Name.	No. acres.	No. of trees.	Age when planted, or height.	Cost of trees.	Cost of planting.	Cost of cultivation.	Distance planted.	Per cent living.	Av'ge growth in feet.	Total cost to date.
Ash, green......	¼	1,360	3 yrs.	$27.20	$6.95	$6.19	2x4	98	.5	$40.34
Ash, white......	2¾	14,974	2	149.74	35.63	4.79	2x4	95	.5	190.16
Catalpa.........	¼	1,361	2	21.77	4.17	2.53	2x4	100	1	28.47
Chestnut........	¼	1,361	2	30.00	6.79	3.95	2x4	50	.5	40.74
Elm, white......	⅛	860	2	4.76	3.95	3.43	2x4	100	1	12.14
Larch, European	2	10,890	1	98.01	21.20	8.50	2x4	25	.5	127.71
Maple, white....	⅛	680	3	8.16	6.17	3 89	2x4	98	1	18.22
Osage orange....	¼	1,361	2	5.44	4.78	1.30	2x4	98	2	11.52
Pine, Austrian ..	¼	680	9to12in	30.00	4.40	2 94	4x4	2	......	37.34
Pine, Scotch....	¼	680	1 to 2 ft	30.00	4.25	3.04	4x4	2	......	37.29
Walnut, white...	¼	1,361	2 yrs.	20.40	3.43	.85	2x4	99	.5	24.98
Willow, white...	¼	1,361	1	8.00	4.67	1.42	2x4	98	2	14.09
Totals......	7	36,749	......	$433.48	$106.59	$42.83	....	....	......	583 00

All the above trees looked very well the first part of the season, but during the latter part the white grub (the larvæ of the May beetle) almost destroyed some of the varieties. They worked mostly on the European larch and white ash, in some instances girdling the roots entirely, from one and a half inches below the surface, several inches down; and owing to the season being so dry, the trees could not repair the injury. White ash two feet high were girdled in the same manner. In the case of the Austrian and Scotch pines we attribute losing so many mostly to the dryness of the season. The Scotch pine were never transplanted before, which we think was one cause of so many dying. Chestnuts were injured somewhat by the grub."

FOREST RECORD FOR 1872.

Names.	When planted.	No. trees.	Age when planted, or height.	Cost trees.	Cost of planting.	Cost of cultivation.	Distance planted.	Per cent living.	Average growth.	Cost for 1872.	Total cost.
Ash, green...	1871	......	....	....	......	$2.52	2x4	98	2½ ft.	$2 52	$42.87
Ash, white...	"	......	....	....	......	18.52	2x4	93	3 ft.	18.51	208.69
Catalpa......	"	......	....	....	......	5.12	2x4	100	4 ft.	5.12	33.59
Chestnut.....	"	......	....	....	......	.75	2x4	4	3 ft.	.75	41.59
Elm, white...	"	......	....	....	......	2.37	2x4	100	3½ ft.	2.37	14.57
Larch, European.......	Re-pl.'72	4,000	1 year..	$30.00	$6.90	30.32	2x4	30	2 ft	67.22	194.44
Maple, white.	1871	......	....	....	......	.72	2x4	98	4 ft.	.72	18.95
Osage orange.	"	......	....	....	......	4.97	2x4	98	5½ ft	4.97	16 49
Pine, Austrian	Re-pl.'72	1,000	9–12 in.	25.00	6.40	6.82	4x4	30	4 in.	38.22	75.56
Pine, Scotch.	"	1,000	12–15 in.	20.00	3.70	4.20	4x4	20	4 in.	27.90	65 19
Walnut, white	1871	......	....	....	......	5.60	2x4	99	2 ft.	5.60	30.58
Willow, white	"	......	....	....	......	5.67	2x4	98	4 ft	5.67	19.76
Pine, white ..	1872	2,722	12–15 in.	122.49	9.85	12.00	4x4	30	3 in.	144.34	144.34
Spruce, Norway........	"	1,360	"	29.94	7.45	10.12	2x4	98	3 in.	47.51	47.51
		10,083	....	$227.43	$34.30	$109.70	....	....	......	$371.40	$958.13

FOREST TREE RECORD FOR 1875 AND 1876.

Varieties.	1875.						Acres..........	1876.						
	Height.		Growth.		Diameter	Cost.		Height.		Growth.		Diameter.	Cost.	Cost from beginning.
	Ft.	In.	Ft.	In.	In			Ft.	In.	Ft.	In.			
Norway Spruce	2	8	...	8	...	$2.55	½	4	3	1	6	...	......	....
White pine	2	8	...	11	...	5 95	1	4	...	2	...	$1\frac{1}{4}$	$1.75	$66.31
Austrian pine	2	8	1	2	...	2.55	⅜	4	8	1	6	2	5.75	362.79
Scotch pine	3	8	1	2	...	2.55	⅜	5	...	1	8	2	1.80	99.76
White ash	11	10	3	2	$1\frac{3}{5}$	6.50	2⅞	15	8	3	4	$1\frac{3}{5}$	1.80	77.39
Green ash	15	...	2	8	$1\frac{9}{10}$	00.00	⅜	17	6	3	...	$1\frac{9}{10}$	5.40	253.46
Catalpa	12	...	2	6	2	1.15	¼	16	...	4	...	$2\frac{1}{4}$	.80	46 69
American elm	12	...	3	...	2	.50	⅛	13	6	2	...	2	.80	39.09
European larch	8	...	3	4	$1\frac{2}{5}$	3.50	1⅛	10	...	3	4	$1\frac{3}{4}$	.50	18.10
Osage orange	10	6	3	...	$1\frac{1}{4}$	1.25	¼	13	6	4	...	$1\frac{1}{2}$	21.80	246.24
Butternut	8	6	3	...	...	1.05	½	10	6	1	...	$1\frac{1}{2}$	1.25	21.96
Black walnut	9	2	2	9	$1\frac{3}{4}$	1.05	⅜	12	...	2	6	2	5.50	43.06
White willow	12	7	3	7	$1\frac{3}{5}$	3.50	⅜	20	...	6	...	2	10.60	18.14
Soft maple	17	8	1	9	$2\frac{1}{3}$	.55	¼	21	...	4	6	$2\frac{3}{4}$	6.20	38.16
Sugar maple	3	...	...	7	...	4.25	½	...	...	...	...	...	.45	25.42
Chestnut (all dead).		...	...	...	...	......	...	...	...	...	...	...	3.75	40.86
Box elder (few trees)	15	7	3	6	$3\frac{3}{8}$	......	...	...	...	...	...	...	......	41.59
Apple (Cultivating)	...	...	...	...	...	......	⅛	7	6	1	...	$\frac{3}{1}$	25.20	....
													1.75	26.95
Cost for the season	...	...	...	...	...	$36.93	...	...	...	...	...	...		
													$95.10	
Cost from beginning	...	...	...	...	...	......	...	...	...	...	...	...	......	$ 1466.97

The foregoing table shows the average height and size of the trees in this plantation, the growth during the summers of 1875 and 1876, and the cost of cultivation, together with the total cost of each kind and the whole plantation from the commencement. With the exception of the chestnut, all the kinds planted are now represented by nearly their full numbers except as removed by thinning. and all are in a healthy, vigorous condition. In 1875 a peculiar blight affected the young leaves and shoots of the sugar maple, but its cause was noi ascertained. It has not appeared this year, and the trees have recovered. A fungus leaf parasite has made its appearance upon the silver leaf maple, forming black shining patches or scabs sometimes an inch across and often several of them upon a leaf. It does not appear to be very destructive, but evidently reduces the thriftiness of the tree. The disease is by no means new elsewhere, being widely disseminated east and west, but not found, to my knowledge, in this vicinity before. No remedy is known to me except the all but impracticable one of gathering the fallen leaves and burning. From the nature of the parasite, this must be a specific where it is possible to make use of it. The scientific name of the fungus is *Rhytisma acerinum*, Fr. The plantation has been remarkably free from insect depredations. Several leaf eating caterpillars have worked upon the elms and walnuts, but not so as to do serious damage. The larva of a butterfly (*Grapta interrogationis*) has defoliated very injuriously the elm trees planted singly, as along streets and on the ornamental grounds, and a sphinx larva in like manner the ash; but upon trees in masses they do not appear to work much.

The only addition made since the last report is a quarter of an acre of apple, planted four by four feet. I recommend the addition of box elder and honey locust, the plants to be grown from seed, which can be obtained at little or no cost. The measurements of a few box elder are given in the table for 1875. They were planted by chance with the white ash and were then of the same age and size of the latter; but at the date given the average height of the box elder was 15 ft. 7 in. against 11 ft. 10 in. for the ash, and the diameter of trunk one foot from the ground, $3\frac{3}{8}$ to $1\frac{3}{5}$ in.

By the showing of the table, the willow is now making the most rapid growth, having gained in average height 6 ft. in 1876. Next comes in order the soft maple

(*Acer dasycarpum*), 4 ft. 6 in.; the catalpa and osage orange, each 4 ft., and the white ash and European larch each 3 ft. 4 in. The two first do not furnish very valuable timber, while that of the four following are very useful. From the most reliable information, we know that the wood of both the osage and the catalpa is almost proof against decay—the dead logs in their native places lie for ages upon the damp ground, hard and sound, while generations of human beings come and go. A log of catalpa certainly known to have lain upon the earth in the wet woods of Pulaski county, Ill., during the whole century of our republic, was sawed into boards, and one of them, perfectly sound and receiving a high polish, helped form the collection sent by this University to the Centennial; a piece cut from the plantation, nearly four inches in diameter, also went with the collection. This was from seed sown in 1869. The osage orange wood, perhaps, is still more valuable, and the woods of the ash and of the larch are highly esteemed. Upon very extended inquiry during the last winter, in connection with the Centennial wood collection, it was found that the price of wood as fuel had not increased during the last ten years in our state, and that in more than half of the timbered regions the growth was estimated to be fully equal to the destruction. With our immense supplies of coal, it is doubtful if wood can, for many years to come, be profitably grown for fuel; but the finer and better varieties of trees, such as are named above, may yield a handsome profit, while natural forests are burned to clear the ground.

The Coniferæ, as indicated by the figures, are growing rapidly—the white pine being first for the last year; the Scotch and Austrian, for the year before. The growth of these trees should not be compared with that of the deciduous ones, because of the natural slowness of their growth when young. In after years they will overtake their present rivals. The proportionately great expense of the larch, walnut, and butternut for 1876 is due to extra work, pruning and transplanting.

FOREST RECORD FOR 1886.

	Acres.	Distance planted, ft.	When planted.	Age in years, or height.	Average height, ft.	Average diameter, in.	Condition.	Cost of trees.	Cost of planting.	Cultivation, etc.	Total cost.	Receipts.
Ailanthus	⅖	4x8	1881	2	18	3⅓	×	$10.40	....	....	....	....
Apple	⅔	4x4	1876-7	4 to 5	18	3⅓	××	50.00	$25.20	$15.00	$90.20	....
Ash, green	3	2x4	1871?	3	40	6	××	76.94	42.58	190.63	310.15	$35.00
Black walnut	¼	2x4	1873	4	37	8	×××	24.00	8.50	21.14	53.64	....
Box elder	⅕	2x4	1877	Seed	31	5	×××	2.00	....	11.00	13.00	20.00
Butternut	¼	2x4	1871	2	30	5¼	×	20.40	3.43	24.23	48.06	....
Catalpa, hardy	⅙	4x8	1881	2	17½	4¼	×××	2.00	5.50	6.50	14.00	8.00
Catalpa, tender	¼	2x4	1871	2	28	6½	×	21.77	4.17	43.37	69.31	5.00
Cedar, red	..	....	1871	2 to 3 ft.	....	....	××	....	....	....	....	....
Chestnut	¼	2x4	1871	2	....	....	......	30.00	6.79	14.65	57.44	....
Elm, American	⅛	2x4	1871	2	29	5	××	4.76	3.95	10.39	19.10	7.00
Hickory, small nut	⅗	2x8	1880	Seed	2-4	...	××	3.50	....	6.00	9.50	....
Hickory, large nut	⅗	2x8	1880	Seed	2-4	....	××	4.50	....	9.00	13.50	....
Honey locust	¼	4x8	1882	2	13	2	××	10.00	6.40	5.00	21.40	....
Larch { on high land on low land.	2	2x4	1871	1	34	8	× ×××	98.00	21.20	189.44	308.64	2.50
Linden	¼	4x8	1881	6	17	2½	××	10.00	6.40	5.60	20.00	3 25
Maple, hard	⅖	2x4	1873	3 to 7	22	3	×××	20.00	10.60	20.26	50.86	65.00
Maple, soft	⅛	2x4	1871	3	44	7¼	××	8.16	6.17	11.09	25.42	....
Oak, bur	¼	4x8	1885	4	2-3	....	××	15.00	6.00	2.00	23.00	....
Osage orange	¼	2x4	1871	2	23	4¼	××	5,44	4.78	14.14	24.34	5 00
Pine, Austrian	¼	4x4	1872	9-12 in	27	6½	××	30.00	4.40	69.36	103.76	....
Pine, Scotch	¼	4x4	1872	1-2 ft.	29	7¼	×××	30.00	4.25	48.14	82.39	2.50
Pine, white	1	4x4	1872	12-15 in	25	5½	×××	122.49	9.85	250.45	382.69	....
Spruce, Norway	¼	2x4	1872	12-15 in	25	5	×××	29.94	7.45	34.92	72.31	30.00
Willow, white	¼	2x4	1871	1	59	8¼	×××	8.00	4.57	27.49	40.16	....
Totals	..	....	......	....	....	....	. ....	$637.30	$192.28	$1029.79	$1846.87	$183.25

In explanation of the above table it may be said that the distance apart is the original spacing of the trees. Most kinds have been thinned. The dimensions of the trees are those taken in October, 1886. The present condition of healthfulness and thriftiness is indicated in the column by crosses. Here one cross stands for poor order, two, fair only, and three, in excellent condition and promising in appearance. In the case of the larch, a double indication is required on account of the difference in the plantation on the low and high ground. In the columns of cost, the exact items are put down when known, otherwise approximate estimates are made. When the young trees were purchased, as was the case with all those planted in 1871 and 1872, except the tender catalpa and butternut, the exact figure is recorded, but when the seedlings were grown on the University grounds the account of cost was kept with the whole forest-tree nursery — not with the separate rows or blocks of different species. So in the cost of cultivation, the amounts named were often obtained by dividing the full amount according to the areas occupied by the kinds. In the column of receipts the amounts are approximate sums. When trees or trimmings were used for the University a definite credit was not usually made, and was not carried to the special kind of tree. The items of cost of the trees and the receipts so far are not regarded as of any importance in the experiment, because they cannot be made use of in arranging for another plantation, on account of the great variation of prices and circumstances. As already said, the small receipts were almost wholly for trees to transplant. Another time or place there might not be such a demand. Certainly no one should count upon such sales as one of the legitimate and regular items of income from a forest plantation. Only in so much as the latter partakes of the nature of a nurerys can the sale of living trees be considered appropriate to it.

When not done directly by the University, the trees were cut away in thinning by men who took the poles for the work. In this way, while no credit is given for the trees, the removal of those in alternate rows, as described, has not cost anything which should be charged against the plantation.

In most instances these trees removed were used for firewood; sometimes, for stakes or poles.

History of the several Varieties.

Ailanthus (*Ailanthus glandulosus*). These trees were grown from seed in nursery, and when two years old transferred to the forest, in 1881. They made a very rapid growth from the beginning, probably surpassing all other kinds in this respect. In four years' time a height of about sixteen feet was attained, with proportional diameter of stem. But during the winter of 1884–5 they were killed to the ground. One large specimen on the University lawn, which had stood unscathed the rigors of fourteen winters, also perished. The following summer prodigious shoots were sent up from the old stocks, some of them stretching up during the single season to eight or ten feet in height. The new growth has been suffered to care for itself, and the block therefore looks rough and uneven. The trees are very irregular in size. Many of those that were not killed entirely to the ground are now 35 to 40 ft. in height and one foot in diameter of trunk one foot from the ground. Sprouts have come up thickly from the roots so that there are trees of all sizes from 2 or 3 ft. up to 40 ft. in height. They have so nearly taken complete possession of the ground where they were planted that no other woody plant except the black raspberry has been able to get a start among them. This habit of root sprouting is one of its greatest drawbacks as an ornamental tree. In the forest plantation where the ground has not been fully occupied by other trees the ailanthus has spread in this way as much as 50 ft. The more the sprouts are cut off the thicker they come up again, but on land that is fully occupied by other trees they seldom sprout.

Aside from the liability to destruction by frost during specially trying winters, it is questionable whether this species has any value for timber. It certainly does grow wonderfully fast, at least when young, and that, too, on poor soil ; but the wood has little value. It is coarse grained with a rather pleasing color, does not take much polish, but when well prepared it might make an agreeable variety for use in some kinds of furniture.

APPLE TREES (*Pyrus malus*). In 1876–77 there was an overstock in the nursery of Perry russet and Stark apple trees, root-grafted in 1872. These trees were in excellent condition, but as no market was found for them it was decided to try some as timber trees. One-fourth of an acre was planted in the spring of 1876 with trees four years old, and a similar area, or a little more, the following season. All had been "cut" with a tree digger in the fall of 1875, but not moved from their place until transferred to the forest. The first were planted 4 ft. by 8 ft. apart, and occupy a block on the west side of the plantation, where they are exposed to the sweep of the prevailing winds of which they clearly show the effects. The outer rows are bent over to the eastward very conspicuously, and the average height is less than would otherwise have been the case. In this block the average measurements in 1886 were: height, 17 ft. 9 in., circumference of trunk, 10 4-5 in. In the second block, planted 4 by 4 ft. apart, well sheltered on all sides, the height was 22 ft., and the trunk same size as above. Four or five years after planting the whole ground became shaded by these trees, after which no undergrowth of any kind, except mosses and other low plants, existed. The trees have grown much more erect than they commonly do in the orchards, but the main stem soon becomes divided into many branches, even when closely crowded. Little can be said in favor of the tree for timber. The wood, if of good size and straight grained, is very valuable for purposes where fineness and closeness of grain, together with hardness and susceptibility of polish, are requisites.

The block of Stark, surrounded on three sides by larger growing trees, is 32 feet in height and ten of them 4 to 5 inches in diameter. Many of them are dead or dying, though apparently not from blight. The trees in the two rows next the white pines are nearly all dead, and the influence of the pines is seen on the third and fourth rows to some extent. The block of Perry russets, fully exposed on the west, seems to have given a strong argument against protection. There are only four rows of these trees, eight feet apart. East of the apple are two rows of basswood that were set five years later and next east of the basswood are black walnuts. The apple trees in the west row are all alive and nearly all in good health. The second row from the west is nearly all alive. More than two-thirds of the trees in the third have died, while in the east row there are only six trees left alive. These trees did not all die at once but have been going year after year for the past eight years.

GREEN ASH, (*Fraxinus viridis*). As has been stated the greater portion of the ash planted was supposed to be white ash (*Fraxinus*

Americana.) Nearly three acres were planted 2 by 4 ft. in one block, and one-fourth of an acre in another block, on, however, similar ground. All proved to be green ash. Both lots were planted in the spring of 1871 and in both cases nearly all the trees grew thriftily from the beginning, gaining 6 in. the first year. Those in the three-acre lot were two-year-old seedlings, the others, three years old; both were from nursery beds. Like the larch and chestnut, the roots of these young trees were considerably gnawed by white grubs the first season, and the losses may be almost wholly attributed to this cause.

The ground upon which the ash are growing is rather low and level. For any agricultural crop, tile draining would materially improve it. The black, vegetable loam is quite deep, underlaid with tenacious yellow clay. An open ditch through the lowest portion carries a stream of water during the first half of most summers.

Cultivation by plow and hoes was thorough during the first four seasons, and afterwards the plow was run occasionally between the rows. When the trees became large enough for planting in shelter belts, streets, etc., a large number were taken here and there from the rows, beginning in 1875 and continuing ten years. In 1876 and afterward whole rows were dug for these purposes, and in 1878 the remaining alternate rows were cut down. The growth of the trees has been exceedingly irregular. Those that get the first start gain more and more upon their shaded companions, so that there may often be found two trees of the same age standing side by side, yet one ten to twenty times as large as the other. Evidently this ash does not succeed well in the shade, though the latter is not dense enough to keep down the conspicuous undergrowth of weeds and many kinds of shrubs. An occasional box elder apparently grows as vigorous surrounded by thickly set ash as though the latter were not present. In natural forests the green ash is found especially on the banks of streams, while the white ash more commonly grows among other trees on rich bottom land. Does the former perish in the shade and succeed in the opening made by the water. In this connection it ought to be noted that sprouts were abundantly sent up from the low stumps left in thinning and that these still make a slender but considerable growth. Some of these are now larger than certain specimens of the original planting.

There is more undergrowth among the ash than appears under any other trees. It is indeed very interesting to observe the great number of shrubby and other growths which normally belong to woods. It will be remembered that the land was originally prairie and had been cultivated in farm crops for thirty or more years, yet one now finds here great numbers of raspberry and blackberry bushes, cherry, Virginia creeper, poison ivy, dogwood, elder, grape, red and black haws, red cedar, besides beggar lice, "stick-tights," and various forest dwelling weeds and grasses; in smaller numbers laurel oak, scarlet oak, white oak, hickory, hazelnut, sassafras, mulberry, hackberry, honey-suckle, gooseberry, currant, cat briar, and a few others. These introduced woody plants now considerably outnumber the ash trees.

They evidently have been brought in by birds, for it will be noticed that the kinds named bear berries or other fruits commonly eaten by birds, or are furnished with appendages by which the seeds or pods adhere to feathers, etc. Great numbers of birds do resort to the plantation for roosting and shelter. The nearest natural wood is about three miles distant.

It is difficult to state the average size of these trees, on account of the extreme variation. In 1886 the better specimens were 5 to 7 in. in diameter and 40 ft. in height, a few running over that. At present the range of diameters is from 1 in. up to 11 in., but the small ones can of course never make anything of value. The average diameter is near 6 in. while the better specimens such as were given seven years ago are from 8 to 9 in. in diameter, and 45 to 48 ft. high. The trunks are tall, slender, nearly free from living branches for half or more of their height and in the main are straight. What are not straight now would become so before reaching a size suitable for making into lumber. The growth of the tree is always greatest on the inside of a crooked place, and unless the crook has been too great, the tree shows nothing of it by the time it is full grown. Among the specimens from 1 to 3 in. in diameter, at least half are dead entirely, or dead at the top. As the trees stand at present each one has a space of about seven feet square, though the distribution is very irregular.

The actual sizes of the trees on the large plat are as follows: 63 are 1 in. in diameter; 653, 2 in.; 657, 3 in.; 516, 4 in.; 392, 5 in.; 257, 6 in.; 131, 7 in.; 57, 8 in.; 9, 9 in.; 1, 10 in.; 1, 11 in.

On the small plat the trees are of the following sizes: 3 are 1 in. in diameter; 1:9, 2 in.; 112, 3 in.; 77, 4 in.; 31, 5 in.; 24, 6 in.; 5, 7 in.; 4, 8 in.; 1, 9 in.

At the end of the first year after planting, the three-year-old trees cost at the rate of $160 per acre, while the plantation of two-year-old seedlings cost $85—the difference coming from the greater original cost of the three-year-old-seedlings and the greater labor in handling them. It requires at least twice the labor properly to plant a three-year-old tree of this kind than it does one a year younger. At the present time no difference can be discerned in the size of the trees.

BLACK WALNUT (*Juglans nigra*). The nuts were planted in the spring of 1869, in nursery. There is, by some inadvertence, a break in the records concerning the transplanting of these trees, and the facts connected therewith, have not been remembered. They were not transferred until after 1872, but in the autumn of 1875 they were over 9 ft. in height, and had been growing vigorously in their permanent place. When transplanted—probably in the spring of 1873—quite a number died, as might be expected of this variety at four years of age. They were put into rows 4 ft. apart, 2 ft. in the row, but the following year were distributed so as to make, as nearly as practicable, the distance in the row uniformly four feet. They occupy three-eighths of an acre on soil of good quality for corn.

In the autumn of 1876 these trees were 12 ft. high and exceedingly healthy and vigorous in appearance. They were fairly well cultivated, and the lower branches were trimmed off so as to leave a smooth trunk 4 or 5 ft. high, but since 1878 no labor has been expended upon them. In 1886 the best of the trees were 37 ft. high and 25½ in. in circumference of the trunk. They were making a rapid growth, with straight, clean stems and fairly good amount of foliage. The latter, however, is never so abundant as in several other species. The better specimens are now 8 to 9 in. in diameter, 40 to 45 ft. in height, and most of them have fairly straight trunks for half to two-thirds their height. The small trees (those running from 2 to 4 in) are out-topped and are beginning to look bushy or dead in the top. There are now standing on the ⅜ of an acre, 176 trees. That does not allow quite ten feet each way for a tree. It cannot be expected that trees standing so close can make the best development long and these will soon need further thinning.

The sizes of the trees on the plat are as follows: 15 are 2 ins. in diameter; 8, 3 in.; 17, 4 in.; 27, 5 in.; 26, 6 in.; 39, 7 in.; 26, 8 in.; 15, 9 in.; 3, 10 in.

There is considerable undergrowth, consisting for the most part of shade-loving weeds and grasses, but also various shrubs and climbing vines.

While these trees make a rapid growth, and ultimately reach a great size, it can hardly be claimed for them that they stand at the head of the list for timber purposes. The wood of old, well grown trees is exceedingly valuable. But it is only the wood of large trunks that commands high prices. That of young trees is not specially prized for anything. From seventy-five to a hundred years is not too great an estimate for the time required for the development of this tree into a product of high commercial value, and who can count upon the relative value of kinds of woods a century hence? Then these large trees demand a large area in which to reach the majestic proportions of commercial prominence. As shelter belts we have better trees, and for furnishing the miscellaneous purposes of farm supply other kinds will be first selected. It is not, however, wished to cast any discredit upon this noble tree—the most prominent representative abroad of our North American forests. Its lofty, feathery crown is worthily worn, and, no doubt, in judiciously mixed planting for timber, this regal tree should have its place.

BOX ELDER (*Negundo aceroides*). The seed was planted in the fall of 1876 thickly in rows 4 ft. apart, where the trees were to grow. The next spring the rows were thinned with the hoe, so as to leave the seedlings at first one foot apart. Two years later every other tree was removed, usually for transplanting. Alternate rows were dug for planting a part at a time as the trees were wanted from 1881 to 1884. During this time the remaining rows were also thinned to about four feet between trees. The area is about one-fourth of an acre in a long strip adjoining the wet portion planted with larch. A part of the ground is very wet in the first part of the season; one end is moderately well drained. The trees have done excellently well throughout, and the block has cost less in proportion to size or number of trees than any other. The first year cultivation was thoroughly kept up during the season, and the second year double shovel plows were run in the rows three or four times. After this the shade was sufficient to keep down the weeds, and from that time to the present the ground has been perfectly free from any kind of undergrowth.

The trees are tall and slender, with clean trunks high above one's head, and they are remarkably uniform in size for such close growth. While the trees appear straight to the casual observer it is almost impossible to find one that is not crooked. The crooks are not short but take the form of long curves. The size (ten years from seed) of the larger specimens, was 30 to 31 ft. in height and 16½ in. in circumference. The larger specimens are now 40 to 45 ft. in height and 6 to 8 in. in diameter at one foot from the ground. This plantation is in appearance very excellent, and, were the wood worth anything, most valuable results might be anticipated. The record is worth consulting in regard to groves and belts for shelter. The tree seems to accommodate itself easily to its place. There is a space of about a rod wide between these trees and the plat of larch, and the outside rows (and especially the outside one) produce much the larger trees, and the trees lean very decidedly toward the open space. As the trees are now standing they have a space of less than 5 ft. square each.

The sizes of the trees on the plat are as follows: Forty-nine are 1 in. in diameter; 93, 2 in.; 85, 3 in.; 105, 4 in.; 72, 5 in.; 50, 6 in.; 20, 7 in.; 13, 8 in.; 2, 9 in.

BUTTERNUT (*Juglans cinerea*). The nuts were planted in nursery rows early in the spring of 1869, and when the seedlings were transplanted two years afterward they were 15 to 20 in. high. Ninety-nine per cent survived and made an average growth the first season of 6 in. At the end of the second year (four years from seed) the average height was 2 ft. In the autumn of 1876 the trees were 10 ft. 6 in. in height. In 1886 the better trees were 30 ft. in height, with a circumference of trunk of 17¼ in. At present (1893) the better trees are from 6 to 8 in. in diameter and from 38 to 42 ft. high. Most of them carry a straight trunk as much as three-fourths of their height. These trees for the first five years received good cultivation and were twice trimmed, taking off the lower branches, which were very heavy and spreading. No pruning has been done among them since. The lower branches have been gradually smothered out and have rotted and dropped off until now very few of the trees have any under twenty feet in height. Most of the trees that are given in the table as 2 and 3 in. in diameter are either dead at the top or are otherwise in very poor condition. As the trees stand at present they occupy only a little more than 7 ft. square each.

The sizes of the trees on the plat are as follows: 37 are 2 in. in diameer; 151, 3 in.; 168, 4 in.; 118, 5 in.; 46, 6 in.; 21, 7 in.; 6, 8 in.; 2, 10 in.

The soil is rather wet yet not too much so for corn growing, except in specially wet seasons. Probably the trees would have done better on drier land. As it is, no kind except the larch on wet land has shown so much disease. But there is nothing in common with these two as to the manner of destruction. With the larch the whole tree assumed a sickly appearance, growth became slow, the foilage thin, and fruit (cones) abnormally produced. Finally the half-dry branches failed to respond to the stimulating influences of spring time and death occurred. In the case of the butternut the difficulty apparently began with the trunk and seemed to be due to frost. The living bark was forcibly separated in patches from the wood, or not unfrequently cracks occurred through bark and wood toward the center of the trunk. In some cases, however, patches of bark on the trunk or larger limbs died without apparent separation, and various fungi afterward grew out of the decaying parts. Indeed, the trees seem to suffer just as orchard apple trees have done throughout the Northwest during the last decade. Trees of this species are not usually healthy or long lived in the native woods of the vicinity. It is not common that good saw-logs can be had from them on account of the irregular growth or unsoundness of parts of the trunk. In deeper woods on richer but better drained land the trees appear in much better condition and not unfrequently free from any apparent defects.

The widest spaces caused by the death of trees as described were filled by transplanting from the thicker rows, but the distribution is still uneven, and not seldom the vacant spaces are now too wide. Although the shade has never been very dense, there is not much undergrowth, except weeds. Altogether the prospect is not favorable for this tree in timber plantations.

CATALPA (*Catalpa bignonioides*). This is the southern or eastern variety, sometimes called the tender catalpa. The seed from which the trees were grown was gathered by Hon. W. C. Flagg, from trees planted by himself upon his farm at Moro, Illinois. At this time (1869) and for several years afterward the distinctions which are now known to exist between trees of this genus had not been made out. Since eastern nurserymen supplied the western parts of the country with most of the nursery-grown trees, and since this tree produces within six to ten years an abundance of seed, it need not be surprising that even in the areas in which the hardy catalpa naturally existed the seeds for planting were mostly gathered from cultivated trees, and so from the eastern or tender kind. This was the case with Mr. Flagg and also with the University. The catalpas planted in the early years were also of the tender kind.

This seed was planted in the spring of 1869 and the seedlings were transplanted 2 by 4 ft. apart in 1871. Having a crooked and much branched top, this was cut off near the ground in the spring of 1872, and a single shoot allowed to grow from each. This latter often attained 6 ft. or more in height the first season — a straight, clean, unbranched stem. In five years the average height was 16 ft. and the average diameter of the stem 2¼ in. The height of the better specimens in 1886 was 28 ft. 3 in., and the circumference of trunk 20 to 21 in. The better specimens at the present time are 7 to 9 in. in diameter and 35 to 38 ft. in height. Very few of them have straight trunks as much as ten feet in length, and most of them are so crooked that it is hard to get good 7 ft. posts without considerable waste. Taking crooked and straight, together with what might be split, the trees would make an average of about four posts each. But few of the trees are perfectly sound. By actual count 132 of the 263 trees give evidence of being unsound, and there are no doubt other unsound ones that do not yet show decay externally. None of the trees have escaped injury by frost. Usually the wood of certain annual growths of the trunk is dead and decaying while many of the limbs, not unfrequently the terminal portion of the "leader," have been killed, making the subsequent growth irregular and crooked. When the trees were 2½ in. in diameter every other one was removed and used as grape stakes. They were cut in the spring and immediately driven into the ground by the side of a vine. Notwithstanding the known durability of this wood in the earth, these stakes rotted so badly that many had to be replaced after the first year, while none lasted longer than three to four years. But it must be remembered that the wood was in part already injured by winter killing and that the stakes were used while green. The sap wood soon decays in the earth under any circumstances, and since in poles of this size there is a large proportion of sap, it is to be expected that such stakes will soon become more or less reduced by rot. But they last much longer if seasoned before setting in the ground and especially if cut in late spring time when the bark peels readily.

Alternate rows were removed six years after planting. As the trees now stand each one occupies an average of a little more than 6 ft. square. The tops of all are thrifty and continue to make good growth. During the past winter one-fourth of the plat was cut down close to the ground and the trees worked up into posts. It is the intention to allow the trees to sprout and grow again from the stump. The sprouts so growing will probably make straighter trees than the originals.

The numbers and diameters of the trees are as follows: 4 are 2 in. in diameter; 34, 4 in.; 71, 5 in.; 61, 6 in.; 50, 7 in.; 28, 8 in.; 9, 9 in.; 6, 10 in.

HARDY CATALPA (*Catalpa speciosa*). The seeds from which these trees came were planted in nursery May, 1876. When two years old the young trees were moved to the permanent plantation and set in rows 8 ft. apart, 4 ft. apart in the rows. From the first these seedlings took an upright growth quite different from those of the tender variety.

The land is the highest and is accounted the poorest in the plantation. It is the same as that occupied by the portion of the European larch which has succeeded so well. As was the case with the other catalpa all the young trees grew — not one died in either case. Notwithstanding the transplanting a growth 4 ft. in height was made the first season. Good cultivation was given the first year, but nothing was done with trees or soil the second season on account of the pressure of business in other quarters. The third year again the ground was kept in good order, after which little attention was given to it.

The trees continued to grow luxuriantly, forming straight trunks, furnished with coarse and distant, but symmetrical branches. Not a bud or branch has been noticeably injured by frost. The average height of the better trees in 1886 was 17½ ft., and circumference of trunk a little over 14 in. This was for six years' growth, or an average of about 3 ft. increase in height per year. Quite a number of the trees have been taken out for transplanting, leaving them, so far as the thinning has gone, 8 ft. apart each way.

The better trees now are 30 to 34 ft. high and 7 to 9 in. in diameter at one foot from the ground. Unlike the tender catalpa these decrease rapidly in size for the first 3 or 4 feet. After that they carry their trunks straighter and hold their size better than *C. bignonioides*. Without a more thorough examination than has been made it would be impossible to tell the condition of the timber in these trees; but two of what appeared to be the best specimens (which were cut for use in a forestry exhibit) were both rotten at the heart from the ground to 8 or 10 ft. in height. Many of the trees taken from the same lot, 6 to 8 years ago, for transplanting soon broke off from one cause or another and all were found to be decayed except a thin outer shell.

The ease of propagation, the usual freedom from disease and injury, the easy success in transplanting, the wonderful rapidity of growth, the excellent form of the tree and the value of the wood eminently distinguish this species as valuable for timber plantations. Its home is upon rich "river bottoms," where the trees attain a height of 80 ft. and a diameter of trunk of 2 to 3 ft., or equal to that of the white ash. But on poor soil it is probable that the mature tree will be smaller than several of the oaks and other first class forest trees. From such information as we have the tree cannot be said to be especially long lived. In the woods they are often found dead and often lying on the ground. Of the proved durability of the wood on or in the ground, too much can hardly be said. Fence posts cut from old logs have remained sound in wet ground forty years, and old stockades have been examined after double this length of time and the wood still found free from decay except the slow wasting away of the surface portions. A log lying across a creek forming a foot-bridge was known by one man to have occupied its place for sixty years, and his information was that at least forty years before his time the log was used for the same purpose. This log was in 1875 cut into boards one inch thick, the widest of which were 18 in. of sound wood. The outer edges were more or less decayed and worm-eaten.

The wood is soft and coarse-grained, is easily worked and keeps its shape well even when cut green. For posts, piles and railroad ties, and for some manufacturing purposes it takes high rank, but for fuel and many special uses other kinds are superior.

The sizes of the trees on the plat are as follows: 11 are 2 in. in diameter; 5, 3 in.; 11, 4 in.; 18, 5 in.; 32, 6 in.; 33, 7 in.; 17, 8 in.; 8, 9 in.

All the trees, except those put down as 2 and 3 in. in diameter, are vigorous and making a good growth.

RED CEDAR (*Juniperus Virginiana*). A few trees of this species were planted when about three feet high in the spring of 1871, on rather dry but rich ground. They stand in two rows about ten feet north of blocks of other trees. They have had except for the first year or two but little attention. The transplanting succeeded well; nearly all the trees lived. They have made a very moderate but steady growth, not, however, appearing very luxuriant or vigorous. The stem usually continues through the head with, however, in numerous cases, competing branches. The head itself is bushy, with close and dense foliage. There is nothing of special promise about them as timber trees on our soil, notwithstanding the recognized value of the wood.

There are now standing only 46 trees; the rest have been cut down or dug out for various purposes. They vary in height from 18 to 25 ft. and are from 5 to 7 in. in diameter at one foot from the ground, and decrease rapidly in size. They would undoubtedly be better for closer planting which would compel them to run up more slender and sooner to lose their lower side branches.

CHESTNUT (*Castanea vesca*). This has been a failure. In 1871 1,360 two-year-old seedlings were planted, of which one-half died the first season. But the roots were badly gnawed by the white grub which existed that year in great numbers in the soil, which was kept clear from other vegetation upon which the worms might feed. As the trees were first set 2 by 4 ft. apart, an attempt was made to make the distribution uniform by transplanting, but the growth continued feeble, and all the trees ultimately died. The land was high and dry adjoining that upon which the larch has so abundantly prospered. A few trees, however, which were set in nursery survived, and after becoming well established have grown rapidly and continue healthy.

It having been asserted that these trees succeeded better if grown from seed without transplanting, the experiment was tried by planting, in the area first occupied by them, fresh nuts in the fall of 1879. These were badly destroyed by rats and other vermin, but such as were left grew very satisfactorily the following year. During the first winter rabbits cut off many of the young stems, and some died. Growth continued poor, and the number of trees gradually became less. Those remaining were transplanted into one row, and now this remnant of the lot are bushy, poor looking, shrubby specimens of little promise. On the other hand some trees three or four year old, received from Mr. C. N. Dennis, of Hamilton, Ill., in 1860, and planted in the arboretum, have done remarkably well. They are exceedingly thrifty, finely proportioned, and gaining as fast as the neighboring ash and elms. No explanation is attempted of the difference. The soil in the latter place is richer. The cultivation was altogether better with those first described.

AMERICAN ELM (*Ulmus Americana*). Only one-eighth of an acre is planted with this common white, or American elm. There are four species of elms native to Illinois. The largest and most abundant is the subject of this report. The next largest, and also next in usual numbers, is the red, or slippery elm, well known for its thick and mucilaginous inner bark. The hickory elm, found in special localities only, is a medium or small sized tree, known, as the common name suggests, for its tough wood and the peculiar wing-like expansion of bark along the branchlets. The fourth species is found in the southern part of the state only, and from the growth of bark on the branchlets, surpassing the latter in prominence, is called the winged elm. It is scarcely more than a tall shrub.

Among these it ought not to be difficult to identify the species with which we are now concerned. Yet such are its variations; so different the appearance of trunk, branches, and foliage; so diverse the characteristics of wood; and withal so many the woodman's names, that many hesitate to put all forms and kinds together as one species. Of the specific unity, however, there can be no question. Many of the observed differences are due to the surrounding conditions, as of very wet and of dry soil, of the chemical or physical characteristics of the latter, of the sweep of winds, etc. But there is also great natural variation in the individual trees when grown under conditions as nearly identical as it is possible to get them in a group or along an avenue. It is entirely probable that seed from individual trees of such species reproduces the characteristics of the parent. Plants that have not been changed under cultivation come more nearly true from seed than those that have been changed. There are comparatively few elm trees that are perfect in shape.

The seedlings were two years old when, in 1871, they were placed 2 by 4 feet apart in the plantation. All lived and grew rapidly.

As they became large enough for the purpose, the most of those to be removed for thinning were dug for transplanting. The better trees measured in 1886 a little over 28 ft. in height and 15 in. in circumference of trunk. These at present are 45 to 48 ft. in height and have a diameter of trunk at one foot from the ground of 7 to 9 in. Of those put down in the table below as 1 to 3 in. in diameter, most have a stunted appearance and some of them are nearly dead. The better ones have nearly straight trunks, free from limbs 20 to 25 ft. in height. The shade is dense enough to keep down most of the undergrowth except what grows naturally in the shade. As the trees now stand they have a space of less than 8 ft. square.

The sizes of the trees in the plat are as follows; 2 are 1 in. in diameter; 22, 2 in.; 13, 3 in.; 8, 4 in.; 15, 5 in.; 14, 6 in.; 11, 7 in.; 4, 8 in.; 6, 9 in.; 3, 10 in.; 2, 11 in. This is far less than the same trees measure planted along streets 50 ft. distant from each other. Even some of those transplanted from these very rows are now twice the average size of their thickly set companions. This seems to show that the elm does not bear crowding well, at least by its own kindred. As a timber tree little can be said in its favor, however much we may admire it for ornamental purposes. There are special uses for its fine-grained, interlocked, fibrous wood, but the demand is limited and uncertain.

HICKORIES (*Carya alba and C. sulcata.*) Nuts were collected of these two kinds, known as the small-fruited and the large-fruited shell-barks, in the autumn of 1879, and at once planted in the forest-tree rows. Some of the nuts were destroyed by vermin, but the most of them germinated and grew the following spring, making, however, small progress during the summer. During the first winter, and to some extent, afterward, many of the young trees were cut off by rabbits. These, however, usually sprouted out again from the stump.

The hickory is naturally of slow growth when young, and the trees are on land that is comparatively poor, high, and dry. In the spring of 1883, the rows as planted were thinned out and the trees taken up were planted in rows 8 ft. apart and 4 ft. apart in the row. Considerable care was taken with the young trees both in digging and setting. The tap root was taken up from 16 to 20 in. long and but little loss occurred from moving. The transplanted trees as well as the others were cultivated for two years; since then they have received no attention except to prune off the lower branches in 1890. In 1886, the trees that had not been removed were from 4 to 8 ft. high, twice as tall as those that were reset. At present the trees not transplanted stand 4 ft. apart each way and are all making a good vigorous growth; the better ones are 15 to 18 ft. high and from 2 to 3 in. in diameter.

The better ones of the transplanted trees are 10 to 12 ft. high and comparatively few of them exceed 2 in. in diameter.

The sizes of the trees in the plat are as follows: Hickories not transplanted, 46 under 1 in.; 252, 1 in.; 63, 2 in.; 5, 3 in.; hickories transplanted, 109 under 1 in.; 364, 1 in.; 37, 2 in.

The land, as before stated, is high and dry and the soil is poor. This is one reason for the slow growth, but the ailanthus and hardy catalpa, on the same soil, have shown remarkable vigor. As between the two hickories, the large-fruited one has surpassed the other, though it is more often found on lower land.

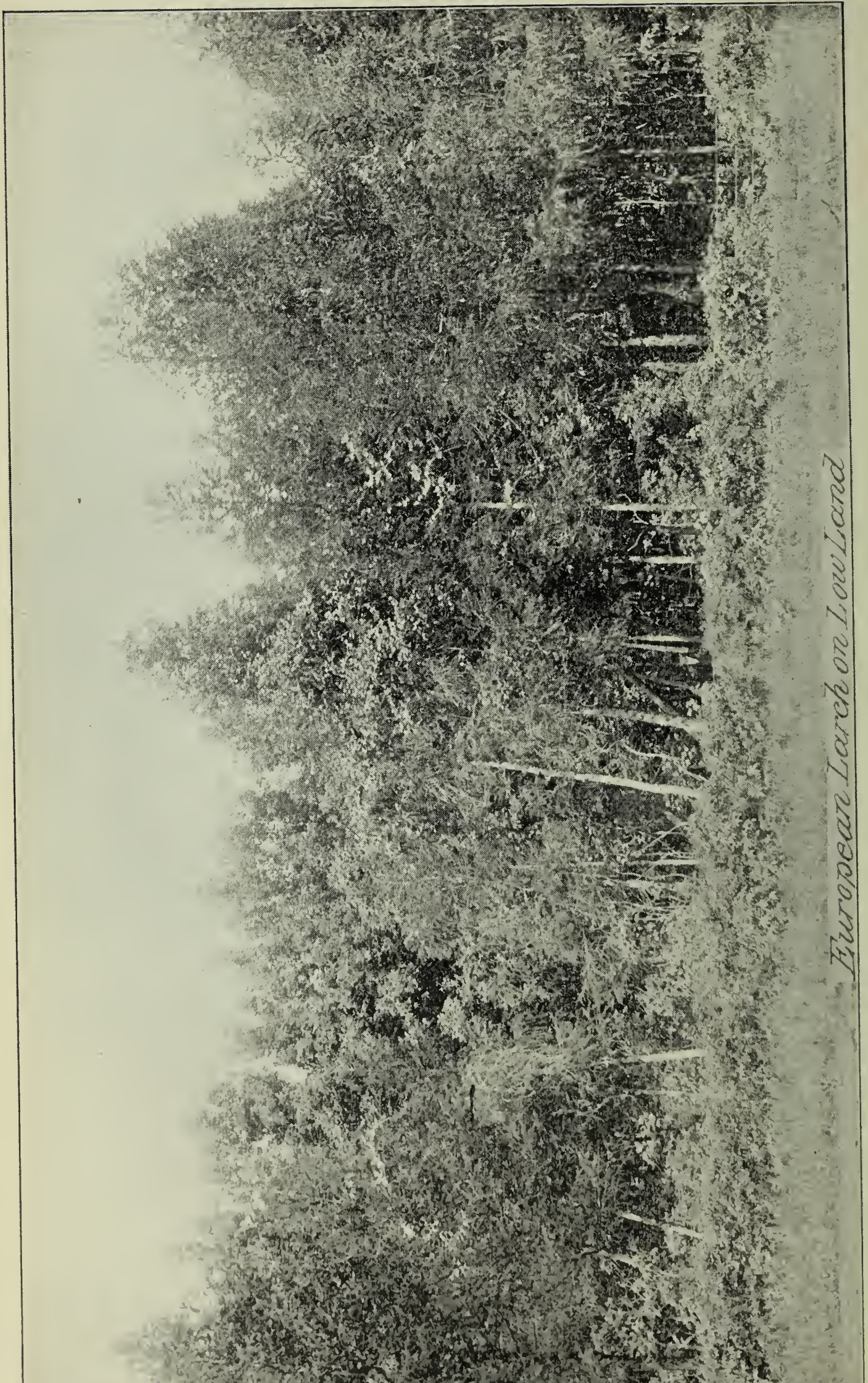
HONEY LOCUST (*Gleditschia triacanthos*). Two-year-old seedlings were planted, 4 by 8 ft. apart, in the spring of 1882. At the time of planting the trees were 4 to 5 ft. in height, and were not cut back in any way. In 1886 the better trees were 18 ft. high and 6½ in. in circumference. At present they are 28 to 32 ft. high and 4 to 5 in. in diameter. All of them look very crooked and if they did not straighten up as they grew older they would be a worthless lot ; but the trunks and larger branches seem actually to bend in their effort to straighten, so that a branch this year does not occupy the same position absolutely that it did last.

This tree attains lofty dimensions in native woodlands, but is not highly esteemed. The wood is coarse-grained, not tough, but exceedingly hard. It is said that it shrinks less in drying than any other native wood. It is not very durable when subject to moisture. There may be special uses for which the hard and conspicuously grained wood would be highly prized. It is susceptible of a fine polish, and probably could be advantageously used in furniture making and in joinery.

The sizes of the trees on the plat are as follows: 71 are 1 in. in diameter; 164, 2 in.; 95, 3 in.; 31, 4 in.; 11, 5 in.; 4, 6 in.

EUROPEAN LARCH (*Larix Europæa*). One and one-fourth acres were planted; rows four, and trees in rows two feet apart. The land varies much in fertility and in subterranean drainage. One-half of the area is relatively high, and in the soil no water stands within several feet of the surface at any time of the year, at least not for many days at a time. This soil is too poor to grow a fair crop of corn, but would answer satisfactorily for oats. The subsoil is yellow clay, with enough admixture of sand to make drainage fairly good. The northern end of the area reaches down into lower land, where water would run from a tile drain during a large part of the spring and early summer, though it does not stand upon the surface. Sometimes in the spring the wettest portion is so soft that a horse's feet would sink three or four inches in the black and rather mucky soil. The seedlings were one year old when planted in the spring of 1871. During the first year three-fourths of these died, more dying upon the high than upon the low ground. All started well, but the roots were badly damaged by the white grubworm, and the season proved to be very dry; during August the dead or dying numbered more than the thrifty trees. Cultivation was diligently kept up during the summer.

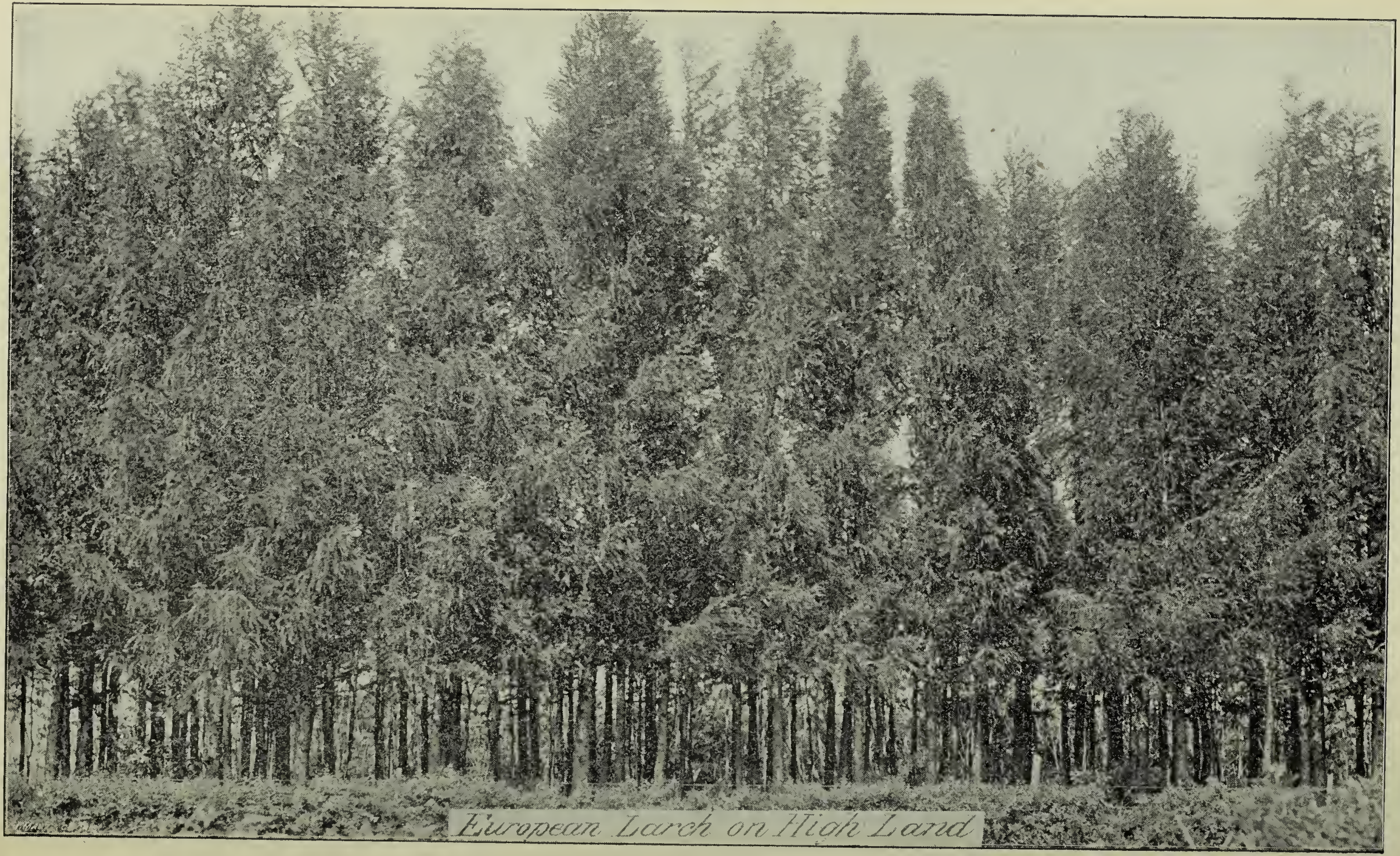
The next spring 4,000 more seedlings were purchased and planted



European Larch on Low Land

in the rows, leaving no spaces of more than four feet. In this way the distribution of the trees was not quite even over the ground, but was sufficiently so to accomplish the object of thick planting. Again the grub-worm did some damage to the roots, but far less than during the preceding season; none was noticed afterwards. Nearly all the trees lived and made a fair growth. Cultivation was kept up during the summers of 1872, 1873, and 1874; but in 1875 the land was so wet during the spring and early summer that it was deemed best not to run the plows. The weeds grew abundantly and made a bad appearance, but they did not seem to injure materially the growth of the trees. At the end of this season, however, it was observed that the trees occupying the wettest portions of the ground looked unhealthy and many were found entirely dead the following spring (1876). Up to this time they had apparently done nearly as well on the low as upon the higher land. Finding that the trees, now five years planted, needed thinning where two feet apart, a considerable number were dug and planted in the vacant spaces. Most of these transplanted trees lived and grew without serious check, but from this time on those on the low ground proved more or less unhealthy. The trees which lived had less than the normal amount of foliage, which was usually yellowish in tint; the branches were slender and wiry, and fruit-cones were abundantly developed. More or less of the trees have died every year until at present, 1893, there are not quite one-fourth as many trees on a given area as on the higher ground. The roots on the low ground run near the surface, with apparently no tap roots. During the spring just past at least ten trees, better than the average in appearance, have been blown down on the low ground, but among the taller trees on the higher ground none have been disturbed by the winds. While there are a considerable number of trees on this lower ground still living, the plantation is anything but attractive or hopeful in appearance. On the higher ground, however, scarcely a tree, except such as have been out-topped, has died or shown any indication of unhealthfulness.

In 1876 the trees in two of the central rows were trimmed by cutting off the lower branches so as to leave a clean trunk 2½ to 3 ft. high. The rest of the trees were left untrimmed, with their branches issuing from very near the ground and spreading so as to interlace with each other. The average height of the trees was at this time 10 ft. These trimmed rows cannot now be picked out, except upon the closest looking for the few remaining dead branches on those not trimmed, and an occasional appearance of the old wounds. But during three succeeding years the growth in height of the trimmed trees was evidently less, and no doubt careful measurements would have shown a similar result for the circumference of the trunks. Unfortunately such measurements were not made. Now the variation in growth in other ways obscures the results, if there are any.



European Larch on High Land

Except in the outer rows there are no living branches under 20 to 30 ft. in height. The dead branches do not rot and drop off readily, being kept from rotting by the large amounts of resin in them, but they are easily broken off. During the winter just past the whole plat has been trimmed to a height of 10 ft., only stopping at that because the man could not reach higher with the tool he was using.

In the winter of 1883-84 a heavy sleet storm broke the leaders out of a few of the trees. While those broken off have made new leaders, they have also started to decay where broken.

During the winter of 1877 and 1878, alternate rows were removed by cutting the trees near the ground. Since the spring of 1889 over 100 of these trees, those below the average size, have been cut down and made into fence posts or grape stakes. The trial has not continued long enough to decide, but the indications are that the larch will not prove specially valuable for such uses.

Since 1880 the ground has been entirely free from weeds, owing to the dense shade of the inwoven branches and the thick carpet of fallen leaves. This plantation on the high ground is a beautiful and encouraging sight. The trees are quite regular in size, symmetrical in growth, tall and straight, with the lower limbs wasted away so that one walks easily under the thick canopy of foilage above, and on the soft and clean matting of the fine leaves below. The height of the better trees in 1886 was 33 ft. 9 in. and the circumference of trunk one foot from the ground 24½ in. At the present time they are 50 to 55 ft. in height and from 7 to 9 in. in diameter at one foot from the ground. There is not much difference in height on account of place in the plantation, but the trees around the outside are usually considerably larger in diameter of trunk.

The outer part of each annual ring becomes very hard when the timber is seasoned, while the rest remains soft. It does not have the appearance of being valuable for lumber except for the coarsest uses, such as framing stuff. No tests have yet been made as to the quality of the wood as grown on the different soils, though there can be little doubt that considerable difference does exist.

Some plantations of the European larch in the state are unthrifty, due, as it appears, to an obscure, or at least not yet determined, disease. The twigs are abnormally slender and the growth poor, the leaves die at any time after appearing, progressively from the outer portions, and prematurely fall. Often new ones are pushed out in little tufts, soon to share the same fate; finally the twigs themselves die. As stated the cause or causes of the disease, if indeed it is a disease, have not been ascertained. But the trouble has not been certainly seen in the University plantation, though indications of a mild form of what seems to be the same exists without damaging results. Early in October—a month before the leaves ought to become discolored and fall—what seems to be another disease has been observed. In this case the leaves assume a sickly yellow hue and gradually drop from the branches, leaving the twigs naked but apparently uninjured. A minute fungus of low type (*Cladosporium*) is found on these fading leaves, even after a long season of fair and dry weather, but it cannot be said that the low parasite is the cause of the trouble, from which the tree appears to suffer but little. Red spiders (mites) sometimes become destructive to the foliage of the larch, as they do, in warm, dry weather, to the leaves of many other trees. (See 14th report Illinois State Entomologist [1884], page 117.)

This larch finds a congenial home in high mountainous regions and is especially valuable as a timber tree in the rough, rocky lands of Scotland. It is on trial now for the prairie regions of our country. While the facts now known of it in these situations are not by any means all favorable, the University plantation on dry ground is certainly in most excellent condition, twenty-two years after planting, and the experiment appears to be eminently interesting and instructive as well as hopeful for practically valuable results in timber growing.

BASSWOOD OR LINDEN (*Tilia Americana.*) The seedlings were collected in the forest in the spring of 1876. It was not the intention at first to put them into the plantation, hence they were allowed to grow longer in nursery than should have been done for this purpose. As it was, however, the smallest trees had been left in the nursery rows, and these were transferred to the forest in 1881, placed 4 by 8 ft. apart.

In 1886, the better trees were 17 to 18 ft., and 8½ in. in circumference of trunk. Now, 1893, they are 26 to 28 ft. in height and 4 to 5 in. in diameter. A considerable proportion of the trees have been broken or otherwise injured, and that causes them to sprout badly around the bottom, otherwise they are well formed and are making a healthy vigorous growth. The trees were cultivated and kept in good shape for the first two years after planting, but since then have received no care.

The sizes of the trees on the plat are as follows: 24 are 1 in. in diameter; 54, 2 in.; 89, 5 in.; 44, 4 in.; 17, 5 in.; 1, 6 in.

HARD MAPLE (*Acer saccharinum*). Seedlings—6 to 12 in. high—were collected in the woods in the spring of 1870, and were placed in nursery rows. Though they had been pulled from the light soil of the woods, and were well in leaf, nearly all lived and grew. However, for the first six to ten years the growth of this tree is very slow, even in rich soil, where alone it thrives. After three years in the nursery some of the trees were transferred to the forest and set 2 by 4 ft. apart. Others were transplanted in the nursery and kept there until 1877, when they were placed 4 by 8 ft. apart in the forest.

There has been considerable call for these trees for streets, etc., and the block has been thinned to about 8 ft. each way between trees by digging from time to time for transplanting. In this way the hard maple has credited to it more than any other species. Yet this is a temporary and local circumstance, which must not be taken as of general application.

The small trees first planted were so slow in growth, and care was so long required, that they cost more in the handling and management than did those left in the nursery a longer time. Under ordinary circumstances, it is no doubt best to give the forest-collected seedlings about three years in close rows, then to transplant them in nursery with wider spaces, to remain three or four years longer; then to transfer to the forest. It would be difficult for any one now to detect the difference in shape and size of trunk of those originally set 2 by 4 ft. apart and those later planted from the nursery 8 ft. distant.

All the trees, either in the nursery or afterward in the forest, had the side limbs removed from time to time, and this certainly added to the temporary appearance of the trees for timber purposes and is essential for ornamental purposes, but is really of doubtful expediency in practical forestry, except to prevent forking.

The land upon which these trees are growing is as rich as that of any of the plantation, and fairly good for corn, but sometimes too wet for early planting to this crop. The trees are now growing rapidly, making clean, straight, beautiful trunks, fairly furnished with branches. The shade is less dense than that of the soft maple plat, but mostly on account of the smaller size and less crowded condition of the trees. The shade being so long in developing, many trees and shrubs, like cherries and raspberries, gained considerable footing, while weeds and grasses were not entirely overpowered. Later much of the undergrowth has been crowded out. The height of the better trees in 1886 was about 22 ft., with a circumference of trunk of 9 in. At present, 1893, they are 28 to 32 ft. in height and 4 to 5 in. in diameter. In the first ten years after planting in the forest the gain in height was nearly 20 ft. In the past 7 years the gain has been about 10 ft.

The sizes of the trees on the plat are as follows: 4 are 1 in. in diameter; 34, 2 in.; 43, 3 in.; 62, 4 in.; 28, 5 in.; 4, 6 in.

This shows good results and indicates that more attention ought to be paid to the hard maple in artificial timber growing. The wood is in demand at good prices for the finer uses, such as furniture, building, implements, etc. Too much consideration has evidently been given to its slow growth at the beginning. Its beauty as an ornamental tree is commonly appreciated and acknowledged.

SOFT MAPLE (*Acer dasycarpum*). One-fourth of an acre, in a strip twenty rods long, was planted with three-year-old trees of this variety, two by four feet apart. Nearly all the trees lived and made an average growth the first year of about one foot in height. They have grown very rapidly each season since. Being larger when transplanted, and furnishing almost at once considerable shade, the ground was more easily kept in order than for most others. Cultivation was, however, kept up three years, and there was some needless pruning the second year.

The only thing done with this block since 1874 has been to thin to four feet in the rows and to remove alternate rows, the latter in the fall of 1876. From the low stumps some straggling shoots have grown; otherwise the shade keeps down nearly all undergrowth. The trees prune themselves, and the dead branches soon fall and decay. The trunks are very tall and straight, of nearly uniform height, but vary a good deal in diameter. The difference in the size (diameter) of the outside trees and those surrounded on every side by others is very striking. These trees cast the densest shade of any of the deciduous trees, with the possible exception of the box elder, so that not only are the various shrubs and weeds nearly excluded, but the trees crowd inexorably upon one another. In 1886 the better trees of this species were 42 to 44 ft. in height, with a circumference at one foot from the ground of about 23 in. At present the better specimens have a height of 50 to 55 ft. and a diameter of 9 to 11 in., in one case reaching 18 in. The trees still stand quite thick, having an average of less than 6 ft. sq. each, if only the area intended to be planted by them is taken into account. But, as there are no trees planted along one side and one end, the outside row, in which the largest trees are found, has considerably more space on which to grow.

The sizes of the trees on the plat are as follows: Fifty-six are 3 in. in diameter; 42, 4 in.; 41, 5 in.; 38, 6 in.; 26, 7 in.; 20, 8 in.; 24, 9 in.; 23, 10 in.; 10, 11 in.; 5, 12 in.; 3, 13 in.; 3, 14 in.; 1, 15 in.; 1, 18 in.

When grown as street trees, subject to bruises and wounds, or on account of any serious check in their progress, wood and bark borers are very common in the trunks, where they do much damage. But in the forest plantation not a sign of these depredators existed up to six years ago. At that time the soft maple plat was fenced off, making it a part of a pasture field. Since then there have been some trees damaged by cattle rubbing against them and tramping about the roots, and the borers have begun to make their appearance.

BUR OAK (*Quercus macrocarpa*). In the fall of 1879 acorns of white and bur oak were planted as soon as gathered, but from lack of proper treatment were all lost soon after they started to grow. Two years afterward a quantity of bur oak acorns was gathered and at once planted in nursery rows. These grew well the following season. In the spring of 1884 the tap roots were cut with a sharp spade, the earth having first been plowed away on one side of the row. The next spring the young oaks, two to three feet high, were successfully transferred to the forest, where they are again making very satisfactory growth. During the season of 1890 many of the trees made growths of 3 to 4 ft. in height. The next year the leaves were badly attacked by a fungous disease, and the growth of the trees was much less, but few of them making as much as two feet. It is of course impossible to say how much of this is due to disease, and how much to difference of season.

There was but little disease during the season of 1892, and yet the growth of the trees was but little more than in 1891.

OSAGE ORANGE (*Maclura aurantica.*) Two-year-old seedlings were planted two by four feet apart in the spring of 1871. After the end of the first season they were two feet high, all living and promising. The location was well adapted to the habits of the tree, except that the catalpa crowded upon them on one side and apple trees upon the other. The soil is good corn land, not usually too wet for early planting. In 1876 (six seasons' growth) these trees averaged 13 ft. 6 in. high, and during the last year had gained from three to four feet. Taking into account the well-known value of the wood, it then appeared, and was so stated in a report upon the plantation, that the Osage orange gave every indication of standing first upon the list of timber trees. As a farm hedge plant its superiority had been fully established, and single trees had often been observed to grow into valuable size with satisfactory rapidity.

After the stems have a diameter of 3 in. they are highly prized for stakes, proving very strong and exceedingly durable. With increase in size the value likewise increases for posts, paving-blocks, etc., and finally for various manufacturing purposes. No other wood serves so well for wagons. For turned handles and other purposes where fineness of grain, hardness, and great strength are esteemed, the wood is especially valuable. Added to these uses is that of fuel. The osage surpasses hickory and maple in this respect.

With such characteristics, combined with rapidity of growth, adaptability to our soils, entire freedom from injurious insects, etc., there is little wonder that the species should take first rank among timber trees. But it is always easy to reach conclusions too soon. The later experience with this block in the experimental plantation falls below the anticipated results. About eight years after planting, the growth became much less rapid, and at this time the trees were slender, with long, straggling branches. In 1876 the average diameter of the stems near the ground was recorded as 1½ in. In 1886 the average height is 23 ft., and the average circumference of stems 13 in. Compare this with the larch, over 33 ft. high and 24 in. in circumference of trunk.

At the present time—1893—the better trees are 28 to 30 ft. in height and from 5 to 6 in. in diameter. A few of them have comparatively straight trunks, 15 to 20 ft. high, and most of the trees would make three good posts each. In March of the present year, one-fourth of the plat was cut down, with the expectation of allowing the trees to grow again from the stump. The trees—forty-seven of them—made 116 posts that have sold readily at 10 cents each. The rest of the plat is better than the part cut. The trunks and main branches have evidently grown straighter with age, though they still give but poor promise of making valuable timber trees in this latitude. However, their great durability in the ground makes them valuable as posts, and it is a question if it would not be worth while for farmers to grow small areas of them for this purpose alone. Like the elm and some others, the crowding in a close plantation seems to injure the development of the individual tree; but unless they are crowded, they make a very short trunk, which is soon lost in the branches. If they were judiciously mixed with other kinds, it is quite likely that better results would be obtained.

Cultivation was kept up for the first four years, and during this time the side branches were kept trimmed off to facilitate the work to be done. The trees, though irregular in size, are no more so than most of the other kinds. While there is considerable undergrowth of other trees and weeds, there is not so much as under either the ash or walnut.

The sizes of the trees on the plat are as follows: Three are 3 in. in diameter; 40, 3 in.; 42, 4 in.; 43, 5 in.; 16, 6 in.; 8, 7 in.: 3, 8 in.

AUSTRIAN PINE (*Pinus Austriaca*). These trees occupy a strip of land 26 rods long, 36 ft. wide, comprising about 3/8 of an acre. The land slopes slightly to the north; the soil is good and the drainage sufficient in an ordinary season, for successful corn growing. The first planting was done in the spring of 1871, the trees were set 4 ft. apart each way. The young trees, 9 to 12 in. high, had been grown in the University nursery, in shaded beds. Nearly all the trees died the first year. These were replanted in 1872, and again a large proportion died. Nearly all the spaces were finally filled, however, in 1873. Cultivation was kept up until 1875, after which time the weeds were mowed for three seasons.

After gaining a hold on the soil the young trees began to grow very thriftily. In September, 1875, the average height was 2 ft. 8 in. A year later they were 4 ft. 8 in. high. No thinning or pruning was done on them until the winter of 1890–91. During that winter the dead branches were trimmed off to a height of 8 to 10 ft.—as high as a man could conveniently reach with an ax. The dead branches were not all taken off at that time, and they have died since, until there is now an average height of about fifteen feet, on which none are living.

At the same time the pruning was done seventy-three dead trees were cut out. These were principally such as had been overgrown, but some had evidently died from other causes. There are now standing in the plat eighteen dead trees, all small, and there are a good many more of the small trees that do not look as if they would live very much longer. There is more variation in height among these trees than in any other of the evergreens. The appearance of the plat as a whole is not so promising as it was eight years ago, though there are still enough trees in apparently good health, and growing vigorously, to fill the space when they are full grown. The trunks are nearly all straight and erect. None of the leaders were broken off by the sleet storm that injured so many of the Scotch and white pines, and there are no double trees among them.

A few Scotch pines were planted in the plat by mistake and they average much larger than the Austrians.

In 1886 the average size of the better trees was given as: height, 27½ ft. circumference, a little more than 20 in. The same comparative grade of trees is at present 35 to 38 ft. in height and 8 to 9 in. in diameter.

Until about eight years ago the trees were so thick and cast so dense a shade as to exclude undergrowth. Now there is a thick growth of weeds, with some raspberries, Virginia creepers, and other wooded plants.

The sizes of the trees in the plat are as follows: Nine are 2 in. in diameter; 31, 3 in.; 63, 4 in.; 58, 5 in.; 52, 6 in.; 21, 7 in.; 13, 8 in.; 4, 9 in.; 1, 10 in.; 1, 11 in.

SCOTCH PINE, (*Pinus sylvestris*). In the spring of 1871, seedlings of the Scotch pine were obtained of Robert Douglas, of Waukegan, Illinois, and at once set in the permanent plantation, in rows 4 ft. apart and 4 ft. apart in the row. The trees when received were 1 to 2 ft. high, and, as an experiment, they had been grown without transplanting. It was hoped in this way to produce trees at a reduced cost, and the result might have been better under more favorable circumstances, but the soil becoming very dry, and the winds scorching and heavy, nearly all the young trees died.

The next season, Mr. Douglas, without charge, refilled the order with transplanted trees, 12 to 15 inches high, and these were planted as the first lot had been. Again, owing to unfavorable conditions, about two-thirds of the trees died. In the meantime trees had been grown in the University nursery, and in the spring of 1873 the plantation was completed so that very few vacant spaces remained. Previous to 1878 a few trees had been taken out for planting in other places, and considerable numbers had died, so that not more than one-fourth of a full stand remained; these, while not very regularly spaced, have taken such complete possession of the ground as practically to exclude all under growth.

No pruning or thinning of any kind was done until the winter of 1890–91, when the dead branches were taken off to a height of 8 to 10 ft., and the dead trees were cut out. Only eighteen dead trees were found, and nearly all of these were such as had been overgrown and smothered. There are now no dead trees standing. Except on the outer edge of the plat the branches are all dead to a height of 15 to 20 ft.

After the Scotch pines became well established, they made a very good growth—more rapid than either the white or Austrian pines; and they are now larger and appear more healthy and vigorous than either of the others. They are very irregular in their habit of growth, so that there are but few straight trunks with single leaders among them. Their irregular habit of growth was made worse by a sleet storm in the winter of 1882–83, which broke off the leaders of nearly half of them. The trees will incline to straighten some with age, and will probably make timber that will be of value when they are full grown.

As the trees now stand they occupy a space of a little more than 8½ sq. ft. each. In 1886 the better trees were reported to be, on an average, 29 ft. high and a little more than 23 in. in circumference at one foot above the ground. At present the same grade of trees are from 38 to 40 ft. high and 9 to 10 in. in diameter.

The sizes of the trees on the plat are as follows: Three are 3 in. in diameter; 14, 4 in.; 33, 5 in.; 41, 6 in.; 50, 7 in.; 46, 8 in.

The plat on which these trees are growing is quite level, with what surface drainage there is, across the rows. The trees were kept well cultivated until 1875, since when, instead of plowing, the weeds were mowed off twice a year with a scythe.

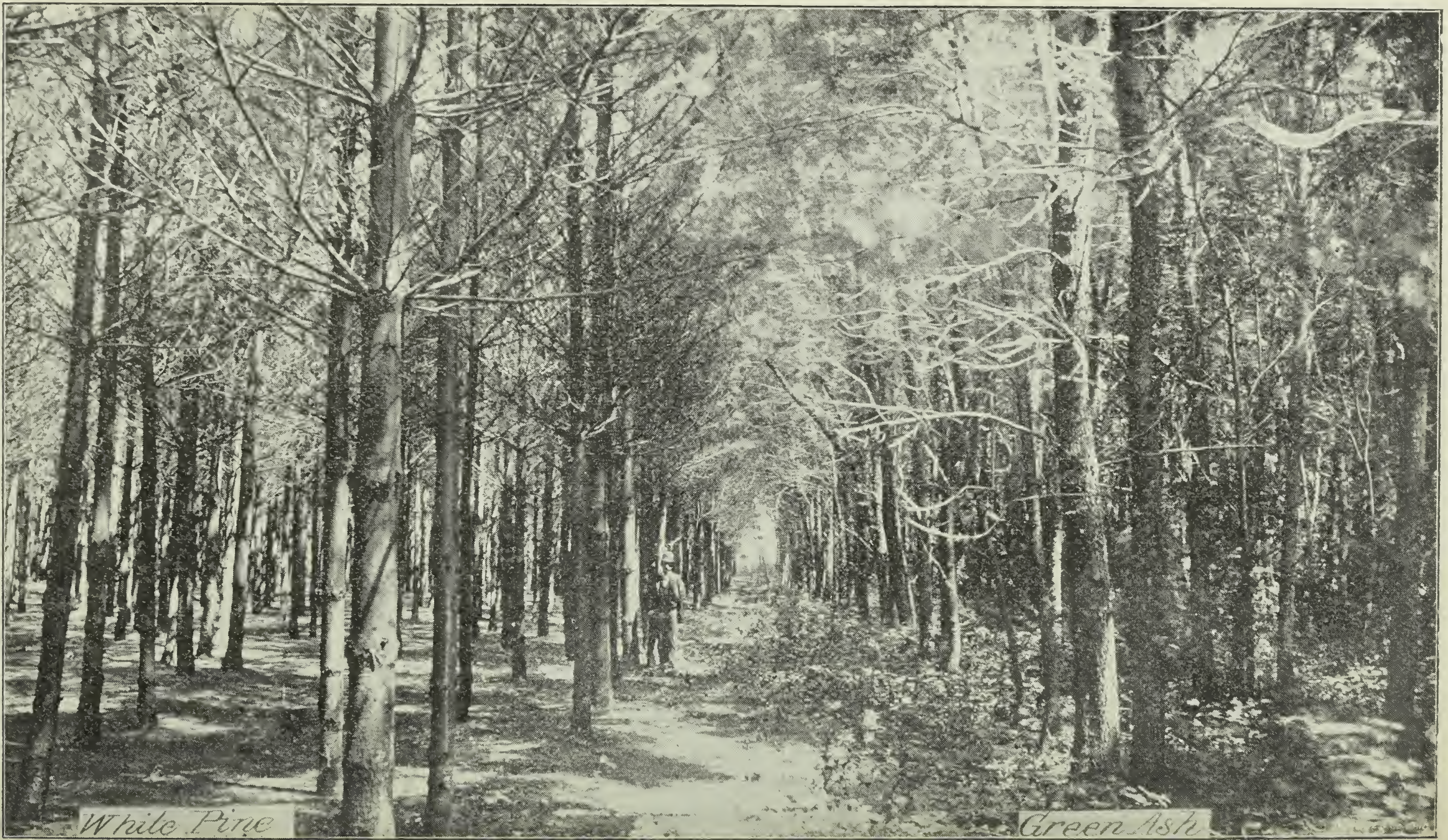
Mr. Douglas writes that these trees were from seeds collected in northern Europe, and belong to what is sometimes called the Riga pine. This statement is important, since it is well known that the *Pinus sylvestris* is very variable, and for timber plantations the varieties differ much in value.

WHITE PINE (*Pinus strobus.*) White pine seedlings were collected in the spring of 1869, put in close nursery rows and shaded with lath frames. About 8 per cent died the first year. Of a few hundred trees, purposely left without shading, 32 per cent died. After having grown in the nursery three years, they were deemed in good condition for transplanting. They were at this time 12 to 15 in. high, well formed, healthy trees.

The land, one acre, where the white pines are planted, is quite flat, what slope there is being to the south; and at least one-half of it is too wet in spring, and often in the early part of summer, for the best results in tillage. The soil is black, part of it mucky, one to two feet in depth, and underlaid, for the most part, with a rather stiff, blue clay. The trees were planted May 4, 1872, 4 ft. apart each way. The white pine is a comparatively hard tree to transplant successfully. The roots are soft, long and naked, with very few small or fibrous roots near the tree. Knowing the necessity of careful handling, no effort was spared, from digging in the nursery to setting in permanent place, to secure successful results.

Throughout the season the ground was kept in a good state of tilth by frequent cultivation, but it was exceedingly dry; and of nearly 3,000 trees planted, two-thirds died during the summer. Of Norway spruce, planted the same day, in the same manner, and on very similar soil, not more than 2 per cent died. It is difficult to explain this greater per cent of loss in the pines, except as we take into account the comparative method of development of the roots of the two species.

In the spring of 1873 the vacant spaces were filled from the nursery, and again in 1874 trees were set where needed. The result of the three plantings was an almost perfect stand of trees. The cultivation with horse and hoe was kept up thoroughly for three years. During the fourth, fifth and sixth years the weeds were mowed. But little cul-


White Pine
Green Ash

tivating was done, because the ground was too wet in the early part of the season.

For a number of years after the white pines were fairly started they made admirable growth, and promised to be very valuable timber trees for the prairie soil here, as well as for their native regions. In a report made in 1886, the following statement is made: "From the first the living trees have done exceedingly well. Very few trees have died from any cause since they began their growth in their present position. They are now remarkably healthy and vigorous, and the plantation vies with that of the larch in beauty and prospective value." At present they are not maintaining the early promise.

No thinning or pruning of any kind was done, except what nature does, until the winter of 1889–90. During that winter and the next the dead branches, to an average height of about 10 feet, were trimmed off, and the dead trees (some more than 350) were cut out. During the winter of 1891–92, sixty-eight more dead trees were cut out, and there are at present fifty-two still standing that have died since the last were cut. The trees cut out the first time had not all died recently. Some of them gave evidence of having been dead for a number of years, while others had died so lately that they still carried dead leaves. Most of the trees that have died were the smaller ones, such as were overgrown or badly crowded. A few only of the larger trees have died. Of the trees still alive, very few have any live branches lower than 20 ft. Many of them have an unthrifty look, either in the top or on the trunk, and the prospect is that there will be a very considerable number of trees to cut out year by year for some time.

The principal reason for so many trees dying is probably overcrowding. As the trees now stand they occupy a space of less than 7 ft. sq. each. The trees have been damaged in other ways than crowding, but not so far as can be judged, until after they had already begun to die. There is continually a thick mat of leaves on the ground, and these have been partially burned off twice, both times injuring the trees more or less from the ground up two or three feet, but apparently not any higher. Boys seem to delight to cut their names or designs in the smooth bark of the trees. Occasionally a tree is entirely girdled. The girdling soon kills the trees, but most of the lesser damage soon grows over. A woolly plant louse (*Churnus pinicorticis*, *Fitch.*) has been very abundant on many of the trees, attacking the trunks and larger branches for several years. They are sometimes so abundant that the whole trunk has from a little distance a white, or grayish white appearance.

The white pines do not cast so dense a shade now as they did ten years ago. At that time there was no undergrowth among them. At present there are some small wooded plants, such as grape, raspberry, cherry, box elder, etc., besides weeds, coming in, and there would likely be more of these were it not for the heavy mulch of leaves that covers the ground.

In 1886 the average size of the better trees was: Height, 24 ft. 9 in.; circumference, 17 in. At present the better trees are 38 to 40 ft. high and 8 to 9 in. in diameter. During the winter of 1882–3 the leaders of a considerable proportion of the trees were broken down by the weight of sleet. This was the cause of many trees being crooked at that point, and of others having more than one leader. Except for the trees deformed in this way nearly all have almost perfectly straight trunks. The trees are much more nearly uniform in height than in diameter.

The sizes of the trees in the plat are as follows: Fifty-eight are 3 in. in diameter; 194, 4 in.; 256, 5 in.; 236, 6 in.; 144, 7 in.; 70, 8 in.; 11, 9 in.; 5, 10 in.

NORWAY SPRUCE (*Abies excelsa*). A large lot of small seedlings were put in close nursery rows in the spring of 1870 and grown there two years. In the spring of 1872 a plat of half an acre was planted 2 by 4 ft. in the low ground on each side of the open ditch that crosses the forest. Although the season was so severe with the other evergreens, not more than 2 per cent. of these died. Comparative ease of transplanting, at least when young, seem to be a characteristic of the Norway spruce, while the opposite characteristic seems to be more or less inherent in the pines.

When set, the trees were 12 to 15 in. high. In the fall of 1875, three years after setting, the trees were 2 ft. 8 in. high, and in the fall of 1876, 4 ft. 3 in., and were making a nearly uniform growth. In 1886 the better trees were about 25 ft. high and 16 in. in circumference. At present they are from 35 to 38 ft. high and 8 to 9 in. in diameter.

These trees have almost from the first taken such complete possession of the ground as to exclude all undergrowth, and there is not now another kind that casts so thick a shade as these. All the trees, except those that are badly overcrowded, seem to be in perfect health. As the trees stand at present, they occupy a space of a little more than 8 ft. sq. A few are beginning to be overcrowded and out-topped. After the trees had got well started, probably in the winter of 1877–8, alternate rows were cut out and the trees left to decay on the ground. Trees were taken out as wanted for planting until 1884. Others have been taken out up to the present time for Christmas and other decorations. Many of them were taken for use in other places about the University and grounds, and no charge was made, so it is impossible to estimate exactly the value of the trees used; but if they were counted at the regular prices, the returns from the Norway spruce would not fall much below those from the hard maples. But as such receipts are only incidental, and not to be relied on under ordinary conditions of forest planting, they cannot serve as a general guide as to profits.

During the winters of 1890–91 and 1892–93 the plat was trimmed up to a height of 7 to 8 ft. Only about half the dead branches were taken off. Four dead trees were found, all of them among the very smallest, such as had been completely smothered.

There is some question as to what the trees will be good for after they have been grown. The size and age they are at present, they last but a very short time. After lying on the ground for two or three years they are so brash as to be easily broken in two. Those 4 to 6 in. in diameter very seldom last more than two years in the ground. When the trees are full grown they would probably make lumber that would answer a very fair purpose for rough work, if kept in dry places.

The sizes of the trees on the plat are as follows: Six are 2 in. in diameter; 43, 3 in.; 42, 4 in.; 78, 5 in.; 65, 6 in.; 53, 7 in.; 35, 8 in.; 9, 9 in.; 6, 10 in.; 1, 11 in.

WHITE WILLOW (*Salix alba*). Cuttings of the white willow were put in the nursery in the spring of 1870. The next spring they were put in their permanent place in the forest. The land on which they were planted is low and level, but is fairly well drained by the open ditch that runs across it.

The trees were planted 4 ft. apart each way, and the first year were allowed to grow as they would. In 1872 the young trees were trimmed to a single stem, but being still straggling and crooked they were cut down to the ground in the spring of 1873. The sprouts thrown up from these stumps grew vigorously. More trimming was done on the willows than on any other species of trees in the forest. After a single straight stem had been established for each tree the growth was very rapid. The willows have almost from the first been taller than any other kind of trees in the forest.

Cultivation of these, as of other trees planted at the same time, was thoroughly done with the plow and hoe, until the fall of 1875, since which time but little was done except to mow off the weeds. The trees have always been crooked at the bottom. At from 2 to 4 ft. in height the trunks become nearly, though never entirely, straight. The trees all carry a single leader to the top. The branches are very easily broken off, even when alive, and so the trees have been continually self-trimmed, making most of them practically bare poles all the time. Willows do not naturally make a dense shade, and this trimming makes them still thinner. As a consequence, the trunks from the bottom up are covered with watersprouts that very seldom live to be more than two years old.

About five or six years ago the willows began dying in the tops, and at present nearly half of them are dead; some only in the top, others nearly to the ground. The undergrowth is nearly as dense here as in the ash, but is of a different character. Not less than half of it is poison ivy (*Rhus toxicodendron*). Virginia creeper is more common here, too, than it is anywhere else in the forest. Other wooded plants are confined almost entirely to the black raspberry and wild black cherry.

In 1886 the larger trees were put down as 59 ft. in height and 26⅓ in. in circumference. The height was probably given a little too great at that time, since the better trees are now only 65 to 68 ft. The best trees are now 10 to 11 in. in diameter, though a few of those that soon fork are considerably larger than that at a foot from the ground.

While these trees have made such a good growth, they do not promise to be of much value except for temporary posts or stakes. The wood is very soft and light. It does not take a high polish, but still is rather handsome when well dressed.

The sizes of the trees in the plat are as follows: Eight are 3 in. in diameter; 44, 4 in.; 52, 5 in.; 60, 6 in.; 50, 7 in.; 62, 8 in.; 45, 9 in.; 26, 10 in.; 12, 11 in.; 6, 12 in.; 1, 13 in.; 1, 14 in.; 2, 15 in.; 1, 16 in.; 1, 23 in.

There is no record as to whether the trees died badly or not when young, but from the irregularity of the stand one would naturally suppose they did. In 1886 the alternate rows were cut out; but it is impossible to decide now which rows were cut and which were left because of the sprouts from the stumps. As the trees stand at present they occupy a space of about 6½ sq. ft. each.

CONCLUSIONS.

Under present circumstances it seems impossible for forest tree plantations to be profitable as a farm crop on land fit for wheat and corn. It is idle to talk of growing wood for fuel—except on farms, for home use—when good bituminous coal can be had at present prices. The fact is, in Illinois, though the extent of the natural forests has been vastly diminished, the price of cord wood does not advance. Lands, even though well timbered, sell at a less price per acre than adjoining lands of the same quality that have been cleared, or than prairie lands of the same productiveness. The value of the timber in such places is less than the cost of clearing and bringing under cultivation. It must, however, be recognized that the value of natural forests gives little information as to the worth of artificial plantations. The former may be mainly composed of what is in the locality most prized; but it is usual that a small proportion only of the trees are those commanding the highest price. In the artificial plantation, judiciously managed, the whole may be high-priced, useful material; this, too, may be more readily accessible and within easy reach of the market.

Let it be clearly understood that in the foregoing, tree-growing for timber has been the point discussed. But the planting of trees has other and higher claims. Whether or not the actual amount of rainfall is modified by forests, there is not the slightest doubt but that the climate is affected. The temperature is equalized; the extremes of heat and cold are not so great. The air is modified as to the amount of moisture, especially in dry times in summer. The moisture of the soil is better distributed through the year. The running streams are better sustained, and also less subject to destructive floods, where the country is well timbered than where the land is kept bare by cultivation and the surface so drained that the water runs away at once. Heavy winds are greatly checked, much to the comfort of man and animals. Crops are preserved in various ways from the destructive influence of air moving too rapidly. Lastly, trees for the ornamentation of the home area, as well as for the wide expanse of the country itself, can never be neglected by a people whose cultured tastes and educated perceptions give them pleasure in the beautiful and the picturesque. To one who has no love for trees as such, half their value is lost. He who can see nothing but wood for fuel or for the manufactory in a shady grove, sees nothing but the dullest and poorest side of life. While it must be insisted that the figures presented by theorists as to the value of timber as a crop are extravagant, and by no means a proper basis for business, tree-planting for the many and varied purposes of health, comfort and pleasure, with financial profit as a subordinate factor, should be studied and practiced by individuals, communities and nations. It is to be hoped that the experiment of which this account is made will not be considered worthless, if the expenditures are never equalled by the receipts.

There is one reason for uneasiness about this experiment, as there must be about every forest tree plantation. The matter is so serious that this report ought not to be closed without a word upon it. The danger of fire is a real and imminent one. The areas bearing the conifers are liable to be burnt over during any dry time, and in autumn, after the fall of the leaves, the portions devoted to deciduous trees are quite as unsafe. A burning wad from a gun, a spark from a pipe, a negligent use of fire by a tramp, may be sufficient to start a conflagration which shall destroy within a few hours the products of years and decades. The incendiary has an abundant chance for the practice of his most despicable and criminal acts. In Europe there is some protection in the *gens d' arms;* American police only beat the thronged streets far away from the farms. Our plantations would not multiply fast if it were understood that a guard must be furnished night and day. It is impracticable to gather the fallen leaves and branches, which, moreover, are necessary as a mulch for the best growth of the trees. There seems to be little offered but to take the risk. If so, this must be included among the items of obstacles and expenses.

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CHAMPAIGN, SEPTEMBER, 1893.

BULLETIN NO. 27.

SOME NEW POINTS IN THE MANIPULATION OF THE BABCOCK MILK TEST.

Testing milk by Dr. Babcock's method has generally been considered a very simple process. The details of the method were so elaborately and carefully worked out by him, before publication, that no improvements in the chemical reactions have been suggested to make the process any more useful or successful than when first described. Beginners have found, however, that to make an accurate test of milk requires somewhat more attention than is necessary to turn the crank of a churn. Many who have used the process have had more or less trouble from foreign substances, either black or white, separating with the fat. These make an obscure reading of the per cent of fat because of the indistinct separation of the liquids. The common remedy suggested for this difficulty has been a change of acid. If there is "black stuff" in the fat, get a weaker acid; if a white curd separates in the fat column, change to a stronger acid. That a too strong or a too weak acid may cause this trouble is undoubtedly correct in many cases, but not always. The manipulation of the test may also cause these defects.

It was found by the writer that nearly if not all the acid sold in Chicago for this purpose was made at one factory, and by conversation with the manufacturer it was learned that the still making this acid was running day and night, turning out the same quality of acid without change.

It has generally been supposed to be easier to test a mixture of the milk of several cows than the milk of one cow, and that possibly there might be found a cow's milk which could not be successfully tested. The observations given in this article are the results of a great many experiments made with the milk of each of the seventy-five cows now in the dairy test at the World's Columbian Exposition.

Since May 1st we have made at least 150 tests of milk every day. During this time samples of a great variety of milks have been tested. There have been great variations in the composition of these milks and in the characteristics and health of the cows. We have been able to test successfully any milk yet received, and by proper manipulation, to get a very clear separation of the fat.

A bad separation is not always caused by the strength of the sulphuric acid. Our work has demonstrated that, by slight changes in the manipulation, at least three kinds of tests can be made of one sample of milk with the same acid.

First, a test giving a very clear separation of fat; *second*, a separation of fat which contains more or less of a black, flocculent substance, especially at the bottom of the fat column; and, *third*, a test very much like the second, except that a white, instead of a black, substance interferes with a clear measurement of the fat.

The black substance that appears is probably charred fat and indicates too strong an action of the acid on the milk. The white adulteration of the fat shows either too weak a reaction or an incomplete separation by the centrifuge. Each of these defects can, of course, be produced by acid either very much too strong or too weak. They can also be brought out, by different manipulation, when acid having the correct strength is used.

If the acid is so poured into the milk in the test bottle that it passes through the milk, instead of following down the inside walls of the test bottle, a portion of the milk is thus acted on by the strong acid before it becomes diluted with the water in the milk. This makes a more intense action of the acid on a small part of the milk, and the fat it contains is somewhat decomposed and blackened. This black substance is then separated with the fat by the usual method of finishing the test and makes the measurement of the fat uncertain.

Another cause of the "black stuff" in the fat is too warm milk. Sulphuric acid, sp. gr. 1.82, may work all right for testing milk when both acid and milk are at a temperature of 60° F.; but if the weather changes, or the testing is made in a warm room where the temperature is up to 80° or 90° F., a great deal of black stuff may be found in the fat.

The action of the acid on the milk will be more or less intense, according to the temperature of the liquids. Persons who have tested milk throughout the year, at creameries or other places, may have noticed that in winter the fat is often light colored or whitish, while in summer it is deeper yellow. This variation in color is caused by the difference in the temperature of the milk and acid as well as the strength of the acid. Cooling the milk in the test bottles, before adding acid, will often prevent the formation of the black substance which appears in the column of fat.

The white, curdy substance that sometimes separates with the fat can be destroyed either by adding the hot water necessary to bring the fat into the neck of the test bottle, in two portions, and whirling the test bottle in the centrifuge after each addition of the water, or by warming the milk in the test bottles, so that it will be about 80° F. when the acid is added.

It is my opinion that returning the supply of acid to the party from whom it was bought is often unnecessary. Any person who has trouble from either the black or white substance separating with the fat can probably remedy the difficulty by some changes in the manipulation, provided the acid is anywhere between 1.82 and 1.83 sp. gr. at 60° F.

No exact experiments have been made yet to determine the relation between the temperature of the milk and acid, and the sp. gr. of the acid, but I will venture to guarantee an entirely satisfactory working of the Babcock milk test if, in addition to the elaborate details which the originator of the method has already worked out, the following precautions are observed:

First—An acid having 1.82 sp. gr. should be used with milk at 60° to 70° F. If the acid is stronger, cool the milk to a lower temperature. Somewhat weaker acid can probably be made to work all right by warming the milk.

Second—When measuring the acid into the test bottles, hold the bottle at an angle that will cause the acid to follow the inside walls to the bottom of the bottle and not drop through the milk in the center of the bottle. If properly poured into the test bottle there will be a distinct layer of milk and acid with little or no black color between them.

Third—Thoroughly mix the milk and acid as soon as measured into the test bottle. A better separation of fat is obtained by mixing at once than by allowing the two liquids to stand unmixed in the bottle until enough tests have been measured out to fill the centrifuge.

Fourth—After five minutes whirling of the test bottles in the centrifuge, add hot water until the test bottle is filled up to the neck only; run the centrifuge one minute, then fill the neck of the test bottle with hot water and run the centrifuge another minute. Adding the necessary hot water in two portions is often a great help in getting a clear separation of fat. When the test bottles are taken from the centrifuge they are put into water at 140° to 160° F., and the per cent of fat read at that temperature.

Fifth—Too low results will be obtained if the centrifuge does not have sufficient speed. The machines have to be watched, as constant use wears some of them so that the speed designed by the manufacturer is not obtained.

Sixth—When testing skimmilks or buttermilks which have a very small per cent. of fat (two-tenths of one per cent or less), the reading of the per cent of fat should be made immediately on taking the test bottle from the centrifuge. If this is not done, and the test bottle cools before taking the reading, the contraction of the liquid in the bottle will often leave the fat spread over the inside surface of the measuring tube so that it is not seen but has the appearance of being only a dirty tube. If read when taken from the machine, the small globules of fat can be seen and estimated.

It has been stated by foreign critics that one reason why they did not use the Babcock milk test was because their work in the dairy line had been done for years by the old methods long in use, and in order to make their present and future work compare with the past they must use the same old methods of their fathers. Our work for the past two months has given each day triplicate proof of the accuracy of the Babcock method for testing milk. The milk of each of the three herds of twenty-five cows is creamed and churned daily. The skimmilk and buttermilk are tested, and the butter from each herd analyzed every day. The butter fat, found by testing the milk of each of the twenty-five cows in each herd, is nearly all accounted for by the analyses of the skimmilk, buttermilk, and butter.

The records show that from June 1st to Aug. 3rd there has been an average loss in fat of 0.166, 0.161, and 0.153 per cent of the total milk produced by the three herds. This small loss of fat by the manufacture of milk into butter demonstrates that if this method is correctly used in dairy experiments, and the results of such investigations are not comparable with those of the past, it is not the Babcock milk test which is wrong. There is some other cause for the discrepancy.

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BULLETIN NO. 28.

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GRAPES, TEST OF VARIETIES.

Experiment No. 40, Grapes; Test of Varieties.

This test of varieties of grapes was begun in the spring of 1888, with the first organization of the Experiment Station.

A comparatively high tract of land with light colored prairie soil is used for the grapes. It slopes gently to the south and is naturally fairly well drained. A line of tile running along the lower side at a depth of 3½ feet makes the drainage still better.

The vines were set ten feet apart each way. This distance gives more room than may seem advisable for general planting ; but it was thought that it would be more convenient for the inspection of varieties by those taking notes or by visitors. The distance apart in the row is greater than is needed by many of the varieties, while others would apparently use more to advantage.

Until the season just past all the varieties were trained to single stakes and a combination of the spur and renewal systems of pruning was used. The past year all were put on a two-wire trellis running north and south. Some varieties, especially the strong growing ones, yield decidedly more when on a trellis than when on stakes and it is much easier to keep them under control and to gather the fruit. Many of the bunches on vines trained to stakes become entangled and it is very difficult to pick them off without cutting them to pieces.

At the time of starting the vineyard all of the varieties standard for this latitude and all of what were considered the most promising of the varieties not standard, fifty-four in all, were planted. With the exception of Concord, Moore's early, Worden, Ives seedling, and Delaware, only a single vine of a kind was set. While this is too small a number of plants from which to judge a whole variety, it did not seem advisable to plant more at that time and this preliminary report must therefore be taken with due allowance for further observation.

The results now obtained cannot be relied on *with certainty* even for the vineyard in which the varieties have been grown, and must be less trustworthy for other places. As an illustration of what is meant, the behavior of some of the varieties of which several vines were planted may be noted. Until the present season, all of the Concords have seemed in as good health as is usual with that variety. This season the leaves on one of the vines began to die about the latter part of July, and by the time the fruit should have been ripe nearly all the leaves were more or less affected, and at least one-third of them had fallen off. As a result of the diseased condition of the leaves, the fruit was very much later in ripening (at least a week or ten days), and it never attained either the size or richness in quality of the fruit on vines in perfect health. The vines also, necessarily, made less growth and ripened their wood less perfectly than those that had healthy foliage. The only difference between the treatment of the vine that was diseased and of those that remained healthy was in the method of training, and this was so slight, that it probably had no effect. Soil and culture were exactly the same, so far as one could judge by observation.

There are eight vines of Delaware growing in the same vineyard. In the season of 1892 one of them shed its leaves early from disease, and the fruit, as a consequence, failed to ripen. Although it was left until the fruit was all gone from the healthy vines, the fruit on this one was still green and sour. This year (1893) the vine that was diseased last year seemed to be in good health, while another one a short distance away shed its leaves prematurely and so failed to ripen its fruit properly. The method of training the two Delaware vines is somewhat different, though both are on a trellis. The behavior of Moore's early has not been the same for all the plants. Some of them shed their leaves so badly as to fail entirely to ripen the fruit ; while on others that held their foliage as they should the fruit ripened well.

The same vine behaves differently in other respects than with reference to disease. During the seasons of 1890 and 1891 one vine of Worden bore larger and much more compact bunches of grapes and seemed to ripen them from 2 to 3 days earlier than the rest. All but this one were more like the Concord in fruit and season than they were like this one Worden. In fact, the similarity to Concord was so great it was decided that an error had been made and new plants were purchased to replace five of the old ones which were grubbed out. The new plants were set in the spring of 1892, and have not yet fruited. Both the crops of 1892 and 1893 on the special vine that had been supposed to be a typical Worden, have been much more like the Concord than the crops of 1890 and 1891. Indeed, it would have passed readily at any time for a Concord, except for the difference in season, and a variation in season is frequently found in the same variety and is the result of different causes, such as disease, comparative amount of crop, cultivation, etc.

In consulting the descriptions of varieties and placing a value on each, it must be remembered that we have but a single plant of a kind, and that individuals of a variety vary as shown above. Many of the descriptions are made up from one year's fruit, and so could not be so accurate as if more time had been allowed. The descriptions are for the fruit and plants as grown here, and many of them would not hold for the same variety grown in other places.

The character of the season makes a great deal of difference in the quality of the grape, aside from what comes as a result of the health of the vine itself. A warm, sunny, and dry season will give grapes of excellent quality, if the vines are in good healthy condition; while a season of the opposite character will give fruit that is sour and poor in quality even on healthy vines. Fruit on a vine that is overloaded will not ripen so early and will not be so good in quality when it does ripen as that on a vine bearing less.

Fruit on vines that have shed their leaves from disease or other cause ripens later than on healthy vines and is always comparatively sour and poor in quality.

The descriptions and estimates of varieties as given here will be found in many instances not to agree with those published in other places, and especially not with those sent out in connection with varieties introduced as novelties. The reason may be easily found. There are few published descriptions of grapes as they are grown so far west as this. In making descriptions it seems to be the practice to use the very best bunches, such as are produced in the best grape growing localities and in the most favorable seasons. As grapes are usually grown, bunches so figured and described are seldom found. The estimates placed on many of the newer things will be found at variance with the introducers'. The one giving the description may be perfectly honest in what he says, but under different conditions the variety fails to develop the characters which he attributes to it. In giving the time of ripening of a variety comparison has usually been made with Concord, because that variety is more generally and better known than any other. The actual time of ripening varies with the season, and of course with the latitude in which the grapes are grown, while the comparative date remains practically the same. The season as it has been found here does not always agree with Downing's statements; for instance, he says Massasoit "ripens before Concord." Our report says, "season about one week later than Concord." Of course there is a possibility of error in the plant we have grown for Massasoit.

The yields have been estimated only, since it has seemed impracticable to secure and weigh the whole crop, except in a few cases. The estimate placed on quality is sometimes made up from fruit that was not entirely mature.

There are in all cases liabilities to error in the variety, both here and in the nursery, but great care has been exercised, both in buying from such houses only as are of known reliability and in keeping records here.

DESCRIPTIONS OF VARIETIES.

In the following descriptions the varieties have been arranged in alphabetical order; first, the black varieties, then the red, and next the white. After these is given a list of varieties that have so far been complete failures here.

There are growing in the vineyard 32 other varieties that have not been planted long enough to get results from them.

BLACK VARIETIES.

AMINIA.—Vine, a vigorous, open grower; shoot, 2 to 5 ft., short-jointed; leaf, healthy, thick, dark green; wood, well ripened. Bunch, medium size, tapering from base to apex; apt to be irregular, and not well filled. Berry, black, with a heavy blue bloom, large to very large, round, full of juice, rich, vinous, and of excellent quality; skin, thick, moderately tough; pulp, tender. Season is about the same as Concord. It keeps fairly well. The yield has been about 8 to 10 lb. each year for the past two years. The bunches are too irregular for a market grape, but the variety would be a good one for the amateur on account of quality.

AUGUST GIANT.—The plant this year has made a weak growth. It had previously been a very fair grower. The foliage has not been healthy. Shoot, 4 to 18 in., short-jointed. Bunch, very small, loose, not shouldered. Berry, small to almost large, often imperfect or immature, round, black with a blue bloom, of moderate quality, very foxy; pulp, tough. Season is 3 to 4 days later than Moore's early. The yield this season was about 1½ lb. The previous year it was about 6 lb. This, as grown here, has not seemed to be of any value.

BACCHUS.—Vine, a very rank, dense, grower; shoot, 4 to 10 ft., slender, short-jointed; the newer wood, heavily downy; leaf, small to medium in size, considerably spotted with disease. Bunch, small, compact, cylindrical, frequently shouldered, regular in shape. Berry, small, round, black with a thin bloom, full of juice, acid, rich, of high quality, appetizing; skin, tender; pulp, tough. Yield fairly good—about 7 lb. this season, and the same last. Said to be good for wine, and to many tastes is good for the table. Season is 4 days to a week after Concord. It would not be recommended for general cultivation.

BARRY.—Vine, a strong, vigorous, moderately dense grower; shoot, 2 to 5 ft., strong, short-jointed, stocky; leaf, dark green, thick, healthy; the lobes overlapping each other. Bunch, short, thick, sometimes shouldered, tapering abruptly and irregularly from the broad base to the tip, seldom perfectly filled. Berry, very large, round, almost black, with a heavy blue bloom, very juicy, sweet, and very rich to the taste; skin, thick, rather tough; pulp, tough. It can be kept until December without much difficulty. Has been a somewhat shy bearer. The crop for the past two years has been about 7 lb. each year. Would be recommended on account of keeping, and excellent quality. Like others of the Rodgers' hybrids, its reputation in other places is not uniformly good for health and vigor of vine.

Cambridge.—The vine, until the past season, was considered a vigorous grower, but this year the growth has been poor; shoot, 1 to 3 ft.; leaves have died and fallen off so that the fruit did not ripen well. Bunch, small to medium; not so large as last season, not well filled, seldom shouldered, tapering from base toward the apex. Berry, about medium size, variable, often imperfect, round, black with a thick bloom, full of juice; skin tender; pulp, rather tough, hard to separate from the seeds; similar in quality to Concord. The fruit ripened this year about 10 days after Concord; last year its season was about the same as Concord, but it ripens unevenly. Yield, about 8 lb. There seems no reason to recommend it for general planting, since the Concord, which it resembles, is better.

Champion.—Vine, a very rank grower; shoot, 2 to 12 ft.; joint, of medium length; foliage, healthy; bunch, small to medium in size. It has seemed to be inferior in quality and has been a very shy bearer. The season is nearly the same as for Moore's early. It could not be recommended.

Concord.—Vine, a very vigorous grower, healthy, rather inclined to make too much wood where it is kept well cultivated or where pruned too close. Bunch, large, cylindrical, usually shouldered, moderately compact. Berry, large round, black with a heavy bloom, of uniform size when well ripened; sub-acid, rather rich, and with but little foxiness when well grown and ripened. Skin, very tender; pulp, tender, meaty. The berry drops too easily from the bunch and the grapes can be kept for a short time only after picking. This is still the standard grape and when a person cares to plant a single variety only, it would be recommended above all others. Even for one who wishes to plant several varieties, the Concord would take the leading place. The vines are comparatively free from disease, though the fruit is more liable to disease in this than in some other varieties. It seems our most regular and most prolific bearer.

Conqueror.—Vine, an excessively rank and dense grower; shoot, 4 to 10 ft.; short-jointed. Parts of the leaves show considerable disease, but this did not come in time to injure the fruit. Bunch, medium size, cylindrical, sometimes shouldered, not well filled, straggling. Berry, medium size, oval, black, with a very thin blue bloom; juicy, of only moderate quality. Skin, tough; pulp, slightly acid. Has not proved a good bearer. The yield this season was about 3 lb., last season a trifle more. It colors some time before it is fully ripe. Season, four days to a week later than Concord. Not recommended.

Cottage.—Plant a vigorous grower, rather open, with thick, leathery leaves; foliage usually very free from disease, though the same vine last season dropped nearly all of its leaves. Shoot, 2 to 5 ft; bunch, small, usually fairly compact, seldom shouldered, oblong. Berry, large, to very large, black, with a blue bloom, somewhat foxy, rank or harsh taste. Skin, thick and tough; pulp, tough. Not so good as Concord. It is a regular but not an abundant bearer. The crop for the past three years has been about 4 to 6 lb. Concords of the same age and with the same treatment yield at least twice as much fruit. The season is about one week earlier than Concord, and that, with its carrying quality, makes it desirable in many places for a distant market crop.

Cynthiana.—Vine, a very rank, dense grower, and very free from disease. Shoot, from 4 to 12 ft., smooth, short-jointed; leaf, large, pale green, the newer leaves yellowish. It continues to grow later in the fall than most other varieties, but the wood is sufficiently matured to prevent injury from cold. Bunch, small, oblong, usually compact and regular with a very long stem. Berry, very small, black, with a thin blue bloom, round, seedy, of high quality. It is of little value except as a wine grape and under our treatment it has been too shy a bearer to be of much value for that. The yield for the past season was not more than one-half a pound and the year before about 2 lb. It may become more productive with age.

Early market.—Vine, a very vigorous grower; shoot, 3 to 6 ft.; strong, well ripened, makes too much wood; leaf, shows some downy mildew; bunch, small, cylindrical, slightly shouldered, compact. Berry, small, round, black with a very thin bloom, juicy skin and pulp tender. The quality is only fair and the appearance is decidedly poor. Its season is two or three days earlier than Moore's early. The yield this season was about 5 lb. The vine is scarcely old enough to have reached full bearing. It has not so far seemed worthy of recommendation.

EARLY VICTOR.—Has usually made a very fair growth. This year it has been very weak and the foliage not healthy. Shoot, 1 to 2 ft.; bunch, small, seldom shouldered, short, oblong, compact. Berry, round, except where crowded, varies greatly in size from very small to medium, black with a blue bloom, very foxy, not juicy. Pulp, tough. About 4 to 5 days later than the Moore's early. The yield the past season was about 2½ lb. The two preceding years it has been about 5 to 7 lb. It does not have enough value as grown here to be recommended.

EATON.—A good grower, open; shoot, 2 to 5 ft., stocky, well ripened; leaf, large, dark green, mostly healthy. Bunch, small to almost large, tapering regularly, very poorly filled. Berry, very large, round, black with thin bloom, juicy, acid with a flavor that is scarcely agreeable; skin, moderately tender; pulp, tender. Season one week after Concord. It seems to be a shy bearer. The yield for the past two seasons has not been more than 1½ lb. Not worthy of recommendation.

EUMELAN.—Plant, a moderate grower, sturdy, healthy; shoot, 2 to 4 ft., short-jointed; leaf, healthy. Bunch, long, usually slender, fairly compact. Berry, medium size, black, round, with a heavy bloom, rich, of high quality; skin and flesh tender, rather dry; seed, large. The yield the past season was about 4½ lb. The previous season it was about 8. While only fairly productive, it should be recommended for general planting for home use on account of its good quality.

ESSEX.—Until the last year the vine has been a good, strong grower, somewhat open. The past season the growth was weak and not healthy. Shoot, from 1 to 3 ft., short-jointed; leaf, pale green, or yellowish. Many leaves dropped prematurely so that the fruit did not ripen perfectly. Bunch, very small, compact, not more than a dozen berries. Berry, very large, round, dark red or almost black, thin bloom and inconspicuous dots, full of juice, acid, not rich, of low quality, somewhat astringent; skin, thick, rather tough; pulp, tough. Not recommended for any one. Season 10 days later than Concord. Yield this year about one lb., and nearly the same or slightly more last year. Berry is of fine appearance, but there is nothing else to recommend the variety.

GAERTNER.—Vine, a strong grower, rather compact; shoot 3 to 5 ft., rather slender, long-jointed; wood, well ripened; leaf, large, very dark green, almost perfect in health. Bunch and berry very much like the Concord or Worden. Season with Concord. Yield about the same or possibly less. It would be hard for any one not an expert to distinguish between them. The resemblance is so close that it has seemed probable that a mistake was made. There is none of the character in this variety that is found in the other of Roger's hybrids, and which seems to distinguish them readily from most other grapes.

HARTFORD.—Vine, a vigorous grower; shoot, 1 to 3 ft. long. short-jointed, vine and foliage, almost perfect in health; shoots and leaves, very downy. Bunch, small to medium size, seldom shouldered, not compact. Berry, large, round, black with a heavy blue bloom, moderately juicy, sweetish, rich in quality, foxy, somewhat rank; skin and pulp, tough; seeds, hard to separate from the pulp. It has been a fair bearer. The yield the past season was about 7 lb. and the previous year about 10 lb. It ripens only a little later than Moore's early. It is not so desirable, however, as Moore's.

IRON CLAD.—The vine is an exceedingly rank and dense grower; shoot, from 5 to 20 ft., slender, long-jointed; leaf, small, dark green, smooth; both vine and leaf very free from disease. The vine would evidently do better with more room than has been allowed it, since, with its past treatment, it makes a great excess of wood. Bunch, small, oblong or cylindrical, compact, shouldered, irregular. Berry, small to medium size, oblate, black with heavy, blue bloom, moderately juicy, slightly acid, but very rich, of high quality, but probably too sharp for most tastes; skin, tender and thin; pulp, separates from the seeds with difficulty. It resembles the Clinton in many respects and would be a good wine grape. Season about same as, or a little later than, Concord. The yield this season was about 3 lb.; last year it was nearly 8.

ISABELLA.—Vine, a rank grower, rather dense, shoot, 4 to 7 ft., downy, short-jointed; leaf, dark green, large, healthy; a fine looking vine with well ripened wood. Bunch, medium to large, long, tapering, rather loose, seldom shouldered. Berry, large, oval, black with heavy blue bloom, juicy, slightly acid, rich, of high quality; hangs well on the bunch; skin, thick and tough; pulp, tender, meaty. The season is about one week later than Concord; but it can be kept for several weeks after being picked, if put in a proper place. It has not been planted long enough to reach full bearing. The yield the past season was about 6 lb. This variety is one of those that color some time before they are ripe, and should be left on the vine for a week or two after being fully colored. It is one of the old varieties but has not been successful over a large part of the country, yet seems very promising here.

IVES SEEDLING.—The vine is a rather rank grower and is generally very free from disease. Shoot, long-jointed and downy; leaf, downy, light green, and deeply lobed. Bunch, above the medium size, compact, but little shouldered, or the shoulder consisting of a few (1 to 4) berries on a rather long stem. Berry, large, with a blue bloom, oval, of medium size, juicy, sweet and free from the foxy flavor; skin and pulp tough, foxy and rank. It begins to ripen about a week before Concord and will hang on the vines until the berries dry up, improving in quality until they begin to shrivel. It stands transportation well and is very productive. Would not recommend it for home use.

JEWEL.—The vine made a fair growth in previous years, but the past year (1893) has seemed nearly dead; shoot, 6 to 18 in.; leaf, yellowish and sickly in appearance. Berry, medium size, round, black with a blue bloom, juicy, sweet, rich with little or no foxiness; skin and pulp tough. This is one of the best varieties in quality, but it has not borne enough so far to make it seem worthy of recommendation.

HUBER'S NO. 12.—Vine, a very strong grower, not dense; shoot, well ripened, downy, slender, joint of medium length, drooping; leaf, large, but little lobed, dark green; a very healthy promising vine. Bunch, medium size, compact, not apt to be shouldered, oblong. Berry, round, black with a heavy blue bloom, varies from small to very large, full of juice, moderately sweet, very rich, drops from the bunch in a short time after picking; skin, rather tender; pulp, tender. Seems to be a moderate bearer. The yield this year was about 3½ lb. Last year it was some more than 4 lb. The season is about one week later than Concord. This is a new variety not yet introduced and has not been planted long enough to come fully into bearing.

MARION.—Vine, a very rank, dense grower; shoot, 4 to 12 ft., rather slender, dark brown, ripe almost to the tips; leaf, large, dark green, healthy, except for the *phyloxera*. Bunch, medium to almost large, shouldered, tapering slightly from base to apex, compact, regular. Berry, medium to almost large in size, oblate, black with blue bloom, moderately juicy, acid, very high in quality, a little too sharp for most tastes; skin, thin and tender; pulp, tough, hard to separate from seeds. Season only three or four days after Concord. It yields well. The crop for the past two seasons has been about 10 lb. each year. The birds seem to take this more than any other variety in the vineyard.

MILLS.—The plant at first made a very strong, healthy growth and seemed promising, but the past two seasons it has grown almost none and appears to be half dead. The bunch is large, heavily shouldered, cylindrical; with many imperfectly developed berries, giving it a very straggling appearance. Berry, medium size, very high in quality; skin, very thick and leathery; pulp, large and tough. Its season is a little later than Concord. The fruit keeps well, but with us it has developed no other quality to recommend it.

MONTEFIORE.—Vine, a vigorous grower, not dense; shoot, 3 to 8 ft.; leaf, large, dark green, deeply lobed and toothed, free from disease. Bunch, medium size, rather long, cylindrical, fairly regular, compact, shouldered. Berry, medium to large, ovate, black with a heavy blue bloom, moderately juicy, moderately sweet, rich, one of the best in quality; skin and pulp tough. The yield the past three seasons has been about 6 to 9 lb. It ripens soon after Moore's early and will keep and hang on the vines until the berries dry up, and continues to improve in quality until after the berries are considerably shriveled. The fruit has seemed less liable to disease than that of many other varieties. It would be recommended for those who like high quality.

MOORE'S EARLY.—Vine, a moderate and rather open grower; shoot, 2 to 4 ft.; joint, medium length. Bunch, medium size, shouldered in the best specimens, not very compact. Berry, large, round, black with a blue bloom, moderately juicy, of very good quality when well ripened; skin, thin, tender; pulp, tender. Ordinarily the plants are healthy; but this season nearly all of them were injured by some disease, the nature of which is not known. The leaves began dying at the edges by the middle of the summer and by the time the fruit should have ripened some of the plants were completely stripped of their leaves. The same disease seems also to attack the young shoots; for when the vines were pruned it was found that the shoots were dead back nearly, or in many cases quite, to the old wood. It is a question how serious the injury to the vines will prove, or how long it may last. The Moore's early is generally conceded to be the best early black grape.

NEW HAVEN.—The Vine, until the past season, has been a very fair grower and healthy. The past season the growth has been weak and unhealthy in appearance; shoot, 8 in. to 2 ft. The leaves have died and fallen badly. Bunch, very small, seldom shouldered, loose. Berry, small to medium, black with blue bloom, round, rather dry, slightly astringent in after taste; skin, tender; pulp, tough. This year it was not so good in quality as it had been in former years, though it has never stood high. Season is only a little later than Moore's early. The yield the past season was about 2½ lb. The variety does not seem worthy of recommendation here.

NORTON'S VIRGINIA.—Vine, an exceedingly rank grower; shoot, 5 to 15 ft., short-jointed; the newer part with a thin bloom; leaf, thick, pale green, badly infested with the powdery mildew. Bunch, medium size, compact, cylindrical with a shoulder sometimes broader at the base. Berry, small, or very small, black with a heavy blue bloom that gives the fruit a bluish appearance, moderately juicy, acid, moderately rich; skin and pulp, tender. This variety has a high reputation as a wine grape and it is of little value for any other purpose. Its season is from 3 days to a week later than Concord. It has proved a very shy bearer so far under our treatment, though it may improve with age. It would also be likely to do better if allowed more room. The yield the past season was about 3 lb. on a vine that was as large as Concords that produce 20 lb.

NORWOOD.—The vine is a fairly vigorous grower without making an excess of wood; shoot, 1 to 3 ft. The leaf and vine have been very free from disease. Bunch, when well filled very large and fairly compact, but a very small proportion only reach perfection. Most of them are very small and loose. The perfect bunches are heavily shouldered and taper from the shoulder almost to a point. Berry, very large, round, almost black with a heavy blue bloom, rather acid, not rich with a musky taste and smell; skin, tough and thick; pulp, large and tough. The fruit ought to ship well, and, where good bunches can be had, sell well. It is not equal to the others of Roger's hybrids or to the Concord in quality. Its season is from one to two weeks later than Concord. It has borne a fair quantity of fruit, yield the past season being about 6 lb. The variety is scarcely to be recommended for the general planter.

ORIENTAL.—Vine has made a very moderate, though healthy growth; shoot, 1 to

3 ft., stocky, short-jointed. The growth the past season was only about half as much as it had been the year before. Leaf, dark green, mainly healthy, but showing some traces of the downy mildew. Bunch, medium size, oblong, seldom shouldered, somewhat irregular. Berry, large, oval, dark red, almost black with a thin bloom, juicy, sweet, very rich, and of high quality; skin, rather tender; pulp, tough. Though it has not been tried for keeping, it has the appearance of a grape that would keep well. Its season is about 3 to 4 days later than Moore's early, and it yields better than that well known variety. The past two seasons the yield has been about 7 to 8 lb. It would not be a good market grape on account of the irregular appearance of the bunches. It is similar in many respects to Montefiore.

POSTOAK GRAPE.—(*Vitit lincecumii.*) Vine, a rank, open grower, short-jointed, strong, and stocky with a bloom on the bark of the new wood; leaf, large, thick and coarse, bright green. This comes as near being a perfect type of health as any variety in the vineyard. Shoot, 4 to 10 ft. Bunch, above the medium size, strongly shouldered, cylindrical, compact. Berry, medium size, oblate, black with a heavy blue bloom and conspicuous dots, meaty, with an agreeable appetizing flavor, quality, high; skin, tender; pulp, moderately tender. Seems to be only a very moderate bearer, but will probably do better as the vine grows older. It is similar in some respects to Norton's Virginia or Cynthiana, but seems decidedly superior to either in quality, yield and size, and would probably make as good a wine grape. It would seem to have very decided value for purposes of improvement; either by crossing with other varieties or by growing seedlings. In season it is about one week later than Concord. This is not a recognized variety, but was sent here simply as a representative of the species. The name *Postoak* is the common name of the species.

VICTORIA.—Vine, a very fair grower, open; shoot, 2 to 4 ft., stocky; leaf, dark green, but little affected by disease. Bunch, very small, short and thick, not more than 10 to 12 berries in the best ones. Berry, large, round, dark purple, scarcely black with a thin bloom, full of juice, mild acid without decided character, poor in quality; skin, tender; pulp, tender, but stringy. The yield was about ¼ lb. this year, and nearly ½ last. Season about one week later than Concord. So far there seems no reason for recommending it here.

J. A. WARDER.—Vine, a strong, moderately dense grower; shoot, 3 to 6 ft., rather slender with but few tenderils; leaf, large, dark green, healthy; very similar to Concord. This is a new variety, originated by Mr. Huber, of Illinois City, Ill., and is not yet introduced. It seems very similar in every way to the Concord, fruit as well as vine. It is two or three days earlier, the berries a trifle more juicy and scarcely so good in quality as the Concord. The berries drop badly from the bunch when picked.

WHITE HALL.—The plant, until the past year, has been a fair grower and comparatively healthy. The past season it was very weak; shoot, only 6 to 18 in.; leaf, yellowish, not healthy. Bunch, small, loose, commonly shouldered. Berry, below medium size, round, or inclined to oval, black with a thin bloom, not juicy; pulp, moderately tender. No note was made as to quality before the present year. Fruit sour, poor in quality, not pleasant to the taste. Its season is nearly the same as Moore's early. It has been a shy bearer. From present indications it is not worthy of recommendation.

WILDER.—Vine, a fair grower; shoot, 2 to 3 ft., slender, joint, medium; leaf, medium size, deeply lobed, dark green, considerably diseased. Bunch, medium to large, sometimes shouldered, tapering from base to point. Berry, medium to large, black, round. It has been a shy bearer so far, though the vine is not yet old enough to show its character in this respect. The yield this season was but about 1 lb.

RED VARIETIES.

AGAWAM.—The vine has been a moderate grower, rather open, and comparatively free from disease until the past year when it has made a weak growth and the whole vine has looked unthrifty. Bunch, small to medium size, usually shouldered where well grown, fairly well filled. Berry, medium size, purplish red with bluish bloom, round, very juicy, slightly acid, rich and very pleasant in flavor; skin, thin and tender; pulp, tender. Until the past year this has seemed an exceedingly promising variety, an abundant bearer and of excellent quality. It would still be recommended for trial to those who care for more variety. The yield the past season was about 4 lb., and the previous year about 8 lb. It is only a little later than Concord.

ALBERT.—Vine, a rank grower, not dense ; shoot 5 to 7 ft., stocky, well ripened ; joint, medium length ; leaf, large, rounded in outline, almost free from disease. Bunch, small, rounded, compact, only 12 to 20 berries in the best ones. Berry, very large, round, red with a bluish bloom, moderately juicy; sweet, spicy, vinous, very rich, taking almost the richness of preserves as it becomes over ripe ; skin, thin and tender ; pulp, a little tough, but separates easily from the seeds. It ought to be a good keeper, but has not been tried. Its season is about the same as Concord. It has not been planted long enough to come into full bearing. The yield this season was about 3 lb. This is one of Mr. Huber's seedlings that has not yet been disseminated. It would seem to be desirable, at least for the amateur.

AMBER QUEEN.—Vine, a strong, sturdy, rather open grower ; shoot 2 to 5 ft., stiff, short-jointed, leaf, thick, leathery, and comparatively healthy. Bunch, medium size to almost large, loose or open, tapering from base to tip, not very regular. Berry, large, to very large, round, light red with a thin bloom and conspicuous dots, full of juice, rather tart, rich, of high quality ; skin, rather tough, pulp, tender, separates easily from the seeds. A fairly prolific bearer. Yield for the past three seasons has been about 8 to 10 lb. each year. Its season is a week to 10 days later than Concord. It is a promising variety so far as tried.

BEAGLE.—Vine, a very rank, dense grower; shoot, 3 to 10 ft.; wood, well ripened; leaf, small to medium, healthy. Bunch, small to medium, slightly shouldered. Berry, small to medium, red with a light bloom, round, very good in quality ; skin and pulp, tender. This has so far seemed to be shy bearer. The crop this season was about 1 lb. It will probably do better as the vine grows older. Season about one week before Concord.

BEAUTY.—Uutil the past year the vine has been a very good grower, comparatively free from disease, and was counted as one of the most promising of the red grapes. This season the vine has been nearly dead, the shoots making only 6 to 12 in. of growth. The leaves began to die early and before time for the fruit to ripen the plant was nearly naked. Bunch, medium size, shouldered, compact. Berry, medium size to almost large, light red with thin bloom, very juicy, mild, very pleasant, not rich, without decided character ; skin, very tender; pulp, tender, separates very easily from the seed. This grape keeps very well. The fruit remained in good condition last year until the holidays. Season a little later than Concord.

BRIGHTON.—Vine, a rank grower, not dense; shoot, 3 to 8 ft.; joint, medium; leaf, good size, very dark, apt to become more or less diseased in the latter part of the season and drop off, though this has not so far seemed to affect the fruit. Bunch, very large varying from compact to loose, broad at the base, tapering irregularly to the tip, can more properly be called branched than shouldered. Berry, above the medium size, round, purplish red when fully colored with a blue bloom, mild, sweet, and exceedingly pleasant flavored without decided character; skin, tender; pulp, very tender, slightly stringy, very juicy, and easily separated from the seed. Its season is about ten days later than Concord. It is at its best soon after it begins to color and loses its sprightly taste when it becomes over ripe. Both the bunches and berries ripen somewhat unevenly. It has so far been an abundant and regular bearer the crop being about 10 to 12 lb. each year for the past three years. It is to be recommended for the amateur or the nearby markets for table use. Complaint has been made in other places that it is liable to disease and lacks hardiness.

BRILLIANT.—Vine, a good grower, not dense; shoot, 2 to 6 ft., stocky, short-jointed, healthy, well ripened; leaf, rather small, comparatively free from disease. Bunch, small to medium, irregular in shape, usually shouldered, not compact. Berry, medium to large, red with a thick blue bloom that makes it almost purple, sweet, rich, vinous. one of the best in quality; skin, tender; pulp, very tender, juicy, separates easily from the seeds. The crop this year was about 5 lb. This is a new variety recently introduced by Mr. Munson, of Denison, Texas. It is so far the most prolific of those of his grapes that we have tried, and is one of the best of grapes in quality. Its season is a little earlier than the Concord. It is to be recommended, at least for the amateur.

CHALLENGE.—Vine, an exceedingly rank and dense grower; shoot, slender, 5 to 15 ft., well ripened; leaf, medium size, dark green, almost perfect in health. Bunch, small, oblong or almost cylindrical, compact, regular, frequently heavily shouldered. Berry, medium size, round, light reddish purple with a very thin bloom and inconspicuous dots, full of juice; slightly acid with little richness; quality good, not high; skin, thin, tender; pulp, tough and hard to separate from the seeds. Season a few days later than the Concord. The yield this year was about 6 lb. Last year there were only a few bunches. Too rank a grower for the space allowed it, and would likely be more productive if given more room. Not recommended.

DELAWARE.—Vine, a good grower, somewhat dense; shoot, 2 to 6 ft., very short-jointed; wood, hard and close grained, well ripened; leaf, small usually healthy, though occasionally dropping from the vine soon after the middle of the season in which case the fruit does not ripen properly, but remains sour and colors but little or not at all. Bunch, very small and compact, shouldered, cylindrical. Berry, round, small, pale red with a delicate color, almost transparent and thin white bloom, full of juice, sweet, rich with a vinous spicy, delicate, flavor that is exceedingly agreeable to most tastes; skin, thin, rather tough; pulp, tender. Plants on stakes have yielded about 4 lb., and those on trellis from 8 to 12 lb. each for the past three years. The Delaware has not proved to be reliable with all growers or in all localities. Two vines which have been growing for about 20 years in another vineyard, less than one-fourth mile away, have been very poor growers and have not been known to so much as produce one pound of grapes in a season. Notwithstanding its want of reliability, it should have a place in every vineyard or arbor where grapes are grown for home use. Its season is nearly the same as Concord, but it will keep much longer.

DIANA.—Vine, a rather rank grower, moderately dense; shoot, 3 to 8 feet., downy; wood, well ripened; leaf, large, dark green, in excellent health. Bunch, medium to large, compact, either cylindrical or tapering. Berry, varying from small to almost large, round, pale red with a thin bloom and brown dots, juicy, sweet, very rich, one of the best in quality; skin, thin and tender; pulp, tender. Season about 8 to 10 days after Concord. The yield this season was about 4 lb. The vine is not old enough to have reached full bearing. It is to be recommended for quality, at least, and its appearance would indicate a fair keeper.

DINKEL.—Vine last year seemed to be a moderately good grower, but this year it is weak; shoot, 6 to 18 in., short-jointed stiff and stocky; foliage, healthy. Bunch, medium to large, broad at the base, narrowing gradually to the point, rather straggling. Berry, medium size, round, light red with a light bloom, juicy, slightly acid, but rich and very pleasant; skin, rather thick and tough, with a slight astringent taste; pulp, tender. It seems to be a shy bearer, but may improve with age. Season 7 to 10 days after Concord.

DRACUT AMBER.—Vine, is a rank, rather dense grower; shoot, 4 to 10 ft. The leaves have been badly diseased the past season and before the fruit was ripe half of them had fallen off. No indications of the disease had been shown in other years. Bunch, small, oblong or cylindrical, very compact when perfect, seldom shouldered. Berry, medium size, round, red in fine specks on greenish white with a thin bloom, full of juice, musky or foxy, slightly acid, moderate in quality; skin, tender, thin;

pulp, very tender. Yield was about 4 lb. for last year and 1½ for this. It ripened this year about two weeks after Concord. In proper health it should ripen nearly with the Concord. It does not seem desirable except as a variety.

GOETHE.—Vine, a moderate, open grower; shoot, 2 to 4 ft.; wood, not well ripened; leaf, medium size, light green, considerably infested with mildew, to which it seems specially subject. Bunch, small to medium, irregular, not well filled, tapering from the base to the tip with many imperfect berries. Berry, medium to very large, oval, pale red with a thin bloom, full of juice, a mild, pleasant almost acid taste, not rich; skin, thin and tender; pulp, very tender and easily separated from the seeds. It keeps very well until the holidays. Its season is about 10 days to 2 weeks after Concord. It has so far been a shy bearer. The yields for the past three years have been about 2 to 4 lb.

HERBERT.—Vine, a very strong, rather open grower; shoot, 2 to 6 ft., strong, light brown, short-jointed; wood, well ripened; leaf, showing some traces of mildew, but otherwise healthy. Bunch, medium size, short and broad, tapering from base to the tip, scarcely regular, open, not shouldered. Berry, large to very large, round, black with a thin bloom, moderately juicy, sweetish, rich, of high quality, but with a slightly acid after taste; skin, thick, rather tough; pulp, rather tough. The yield the past season was about 5 lb. The vine is scarcely old enough to be in full bearing. Season about 4 days to a week after Concord.

IONA.—The vine has grown well until the past year when it was very weak; shoot, 9 to 18 in.; leaf, yellow, and sickly, but apparently free from fungus diseases. Bunch, medium size, not well filled, tapering from the base to the tip. Berry, of medium size, oval, light red with bluish bloom, moderately juicy, sweet with a rich pleasant flavor, one of the best in quality; skin, thin and tender; pulp, tender. Its season is about 7 to 10 days later than Concord. The yield this season was about 2½ lb. It seems so far to be too shy a bearer to be recommended.

JEFFERSON.—Another of the varieties that have not done so well the past year, either in growth or fruit, as they had previously. Bunch, small, imperfect. Berry, medium size, round, bright red with a thin bloom, juicy, rich, neither sweet nor acid, very agreeable, best in quality; skin, tender; pulp, tender, meaty. The yield the past season was about 1 lb. and the year before 6 lb. This variety had been considered one of the most promising of the red grapes, but the results of the last season would not justify recommending it.

LINDLEY.—The vine is a strong grower, without making an excess of wood, healthy; wood, well ripened; leaf, comparatively free from disease. Bunch, large, shouldered when perfect, usually not well filled, tapering from the base to the apex. Berry, very large, round, red with thin bluish bloom, full of juice, slightly musky sweet, rich, one of the best in quality; skin, tender, pulp, rather tough, but small. Its use would be table or market. It would sell well either from its appearance or on its merits, and would bear shipment better than Concord which is about the same in season. It has proved so far to be a prolific bearer. To be recommended highly for home use or market.

LYON.—Vine, a very rank and dense grower; shoot, numerous, 2 to 8 ft., long-jointed, smooth. Bunch, very small, oblong and compact, seldom, if ever shouldered. Berry, small, round, dark red, dry, pleasant flavor, rather sweet and rich; skin and pulp, very tender. Season one week earlier than Concord. It seems to be a shy bearer. The yield for this season was about ½ lb. and for the previous year about 2 lb.

MASSASOIT.—Vine, a moderate, open grower; shoot, 2 to 4 ft.; wood, not well ripened. Bunch, above medium size, short and thick, irregular, tapering from a broad base to the tip, only moderately well filled. Berry, large to very large, round, reddish amber with a thin bloom, full of juice, slightly acid, mild and very pleasant, but not high in quality; skin, thin and very tender; pulp, very tender, would please the taste of a great many. The season is about one week later than Concord. It is a very fair bearer. The yield for the past three years has been from about 6 to 10 lb. It would be recommended to the amateur or for a fancy market.

MOYER.—Plant, a very slow grower with shoots of only 1 to 3 ft. per year, short-jointed, bushy, compact. Unless it grows stronger in other places it could be planted 4 feet each way. The foliage has not been healthy, Bunch, very small, compact, usually well filled, the larger ones shouldered, oblong, regular, Berry, medium size, red with a blue bloom, moderately juicy, sweet, rich of very good quality. The yield for the past two years has been about 2½ lb. It might be recommended for the amateur who desires a long list of varieties. Its season is about one week earlier than Concord.

NORFOLK.—Vine, a strong grower, somewhat open; shoot, 4 to 10 ft., stocky; wood, not well ripened; leaf, large, rough, subject to downy mildew. Bunch, medium to large, broad at base, tapering irregularly to the tip, usually well filled. Berry, oval, large, reddish purple with a blue bloom; juicy, slightly acid, but very pleasant and agreeable; skin rather tough, thick; pulp, tough and hard to separate from the seeds. Its season is about 10 days after Concord. It has so far been a shy bearer. The yield for the past two seasons has been only about 4 lb. each year. It could scarcely be recommended except for the sake of variety.

ONEIDA.—Vine has made a very weak growth this year and is not at all healthy. shoot, 4 to 12 in., leaf, yellowish green, not healthy, Its diseased condition would affect the quality of the fruit and the ripening of the wood very decidedly. Previous to this season it seemed to be a fair grower and comparatively free from disease. Bunch, small to medium, cylindrical, not shouldered, well filled, fairly regular. Berry varies from very small to medium in size, round, white to bright pink with a very thin bloom, sweet without richness or other decided character, flat; skin, very thick and tough; pulp, tender, meaty. Its season is two weeks later than Concord. It would probably keep well. It is a shy bearer and could not be recommended.

PERKINS.—Vine has made a moderately healthy, stocky growth; shoot, 2 to 6 ft., joints usually short; wood, well ripened; foliage, comparatively healthy. Bunch, small, seldom shouldered, cylindrical, commonly well filled and regular. Berry, large, oval, light green and red with a thin bloom, moderately juicy, sweetish, flavor good, foxy; skin, very tender; pulp, very tender, meaty. This variety produces fairly well. The yield the past three years has been from 6 to 10 lb. It ships well and is grown to some extent as a market grape. It has not seemed so desirable here as many other varieties.

ROCHESTER.—The vine made growths two years ago of 2 to 6 ft. and appeared vigorous and healthy. The past year the shoots were only 6 to 18 in. with small, yellow sickly leaves. Bunch, medium to almost large, broad at the base, tapering to the tip, compact, often imperfect. Berry, medium size, variable, round, purplish red with a thin bloom and small dots, full of juice, acid without high quality; skin, thin, astringent; pulp, stringy. The season was two weeks or more later than Concord. It would undoubtedly have been earlier and of much better quality if the vine had been in good health.

RUBY.—Vine, a very vigorous and dense grower; shoot, 2 to 8 ft., healthy, well ripened; leaf, perfectly healthy. Bunch, small, shouldered, very imperfectly filled, only a few good berries on each, the rest only partly developing. Berry, medium to large, round, red with greenish stripes, mild, pleasant, not of high quality; skin, very tender; pulp, very tender, meaty. It has been a very shy bearer but will improve with age. There was not more than one-half a pound on a vine that was large enough to have borne 10 or 15 lb. Its season is nearly the same as Concord.

SALEM.—Vine, a fair grower, though not so strong this year as previously, open shoot, 1 to 5 ft., fairly well ripened; foliage, fairly healthy. Bunch, medium size, short and broad, tapering from base, not regular, not well filled, loose, seldom shouldered. Berry large to very large, red with a thin bloom and inconspicuous brown dots, round, full of juice, of very pleasant taste, and sweetish, good in quality, without decided character; skin, rather thin and tough; pulp, easily separated from the seeds, slightly stringy. Season, about 4 to 7 days later than Concord. It has been only a moderate bearer. There are others of Roger's hybrids very similar in character that have been very much more productive.

ULSTER PROLIFIC.—Vine has been a very weak grower; shoot, 1 to 2 ft., slender, short-jointed; wood, well ripened; leaf, small, yellow without apparent disease. Bunch, small. Berry, small, round, bright red, of very good quality. The yield for the past two years has been about ½ to 1 lb.

VERGENNES.—Vine, a moderate grower; shoot, 1½ to 3 ft., short-jointed; leaves have nearly all died and fallen off. It has not done so well the past season as it had before. Bunch, small to medium size, oval, scarcely shouldered, compact, regular. Berry, nearly round, light red with a thin bloom and conspicuous dots; varies from medium or small to large in size, juicy, sweet and rich; skin, thick, rather tough; pulp, very tender, separates easily from the seeds. The yield is about 8 lb. Its season is some earlier than Concord. Until the past season this had been considered a very promisingred grape. It may not show the same failing next year, but until after a longer trial it could not be recommended with any degree of confidence.

WOODRUFF RED.—Vine, a moderately good grower; shoot, 2 to 3½ ft., short-jointed; foliage only fairly free from disease. Bunch, medium size, frequently shouldered, very compact, oval, or oblong, regular. Berry, large, light red, bloom, thin, juicy, sweet, rich; skin, very tender; pulp, tender, easily separated from the the seed; very good in quality. Its season is about 3 to 4 days after Concord. The yield for the past two seasons has been about 8 lb. a year. It would be recommended to the amateur for home use or for a near market.

PETER WYLIE.—The vine has proved. to be a weak grower always unhealthy in appearance. Bunch and berry, very small and not of a desirable quality. From experience here it could not be recommended for any purpose,

WYOMING RED.—Vine, a rank, moderately dense grower; shoot, 3 to 8 ft.; wood, healthy and well ripened; leaf, pale green, glossy, comparatively healthy; Bunch, small, oblong or tapering slightly from the base, moderately compact. Berry, a clear light red with a bluish bloom, medium size, oval, juicy, sweetish, very musky, quality good; skin and pulp, rather tough. The rats sometimes take it very badly, while they seldom trouble the other varieties. It is a rather shy bearer. Its season is about 3 to 4 days later than Concord. It is not to be recommended except to add to the number of varieties.

WHITE VARIETIES.

ALPHONSE.—Vine, a strong grower, open; shoot, 2 to 5 ft., downy, slender, short-jointed; wood, not well ripened; leaf, somewhat subject to disease. Bunch, medium size, not well filled, usually with a small shoulder. Berry, large, oval, creamy white with thin bloom, but little juice, mild, pleasant, without decided quality; skin. tender; pulp, very tender, breaking. This has been a very shy bearer yielding less than 1 lb. either last year or this. Its season is a little later than Concord. This is a new variety not yet disseminated, and from experience here so far could not be recommended. It may improve as the vine grows older

BARBARA.—Vine, a fair open grower; shoot, 2 to 3 ft., slender; wood, well ripened; leaf, of medium size, comparatively free from disease. Bunch, small, irregular. Berry, medium size, creamy white, almost yellowish white, rather dry, sweet, rich, of excellent flavor; skin, thin and tender; pulp, very tender, meaty, breaking. Seems to be a shy bearer. Yield this year was abont 1 lb. This is a new variety not yet introduced and has not been grown long enough to reach full bearing.

BELL.—Vine, a rank, rather dense grower; shoot, 3 to 8 ft., long-jointed, strong; leaf, generally free from disease. Bunch, small to medium size, not well filled, usually shouldered. Berry, medium size, white with a slight bloom, juicy, and agreeable; skin, tender; pulp, very tender; of excellent quality for eating or table use. It has been a shy bearer so far, but the vine has not been set long enough to reach full bearing. The yield the past season was less than 1 lb.

CAMPBELL.—Vine last year seemed to be a fairly good grower and productive. This year it has made a very weak growth and does not appear healthy. Bunch, small, imperfect. Berry, medium size, white with light bloom of excellent quality; skin, very tender; pulp, exceedingly tender and meaty. Its season is about one week earlier than Concord.

CENTENNIAL.—The vine has grown well and seemed healthy until the last season when it made a poor growth; shoot, short and stocky. Bunch, medium to large, usually shouldered in good specimens, tapering from the base to the tip, compact. Berry, small to almost medium size, round, greenish white with a purplish, bluish, and thin bloom, full of juice, slightly acid, very pleasant, moderately rich, agreeable flavor; skin, tender, thin; pulp, moderately tender. The yield for the past two seasons has been about 6 lb. each year. It ripens about two weeks after Concord. The bunches are very imperfect and present an uninviting appearance.

DUCHESS.—The plant made a very good growth for the first three years, but the past season it has been sickly and the growth very weak. Bunch, medium size, loose, tapering from the base to the tip. Berry, medium size, white, acid; quality only fair. The crop for the past year was about 1 lb. and for the year before about 10 lb.

ELDORADO.—Vine, a moderate grower, healthy. Bunch, of medium size or below, usually not well filled, shoulder large. Berry, round, greenish white with a white bloom, variable in size and often imperfect; mild, pleasant, sweet, not rich or foxy; quality very good; skin and pulp, tender. Season is nearly the same as Moore's early. Use, table or near market. It would not bear much handling. It is only a moderate bearer.

ELVIRA.—Vine, a very strong, dense grower; shoot, 3 to 6 ft., short-jointed; wood, well ripened; leaf, almost perfectly healthy. Bunch, small, very firm, ovate or oblong, seldom shouldered. Berry, crowded, compressed, greenish white, medium size, varying to small, moderately juicy, acid, of poor quality; skin, very tender; pulp, meaty, very tender. The crop for the past three years has been from 8 to 15 lb. Its season is a little later than Concord. It might be recommended for making jellies, etc.

EMPIRE STATE.—Vine, a good grower, moderately dense; shoot, 2 to 4 ft., branching, short-jointed; leaf, subject to downy mildew. Bunch, small, oblong, regular, seldom shouldered, compact. Berry, medium size or above, round, pale, greenish white with a very thin bloom and a few inconspicuous brown dots, almost transparent, juicy, sugary sweet, not of high quality; skin, thick, moderately tender; pulp, tender. The yield this season was about 10 lb. It ripens about one week later than Concord. It might be of value to one who likes a very sweet grape but does not care so much for other qualities.

ETTA.—Vine, a rank, dense grower, healthy; shoot, 3 to 8 ft., rather stocky, short-jointed; leaf, thick, large and healthy. Bunch, small, oval or oblong in outline, very compact, not shouldered. Berry, small to medium size, oval from being compressed, greenish white with a thin whitish bloom, full of juice, acid not rich, but pleasant and agreeable when fully ripe; skin, tender; pulp, tender. This variety is a very prolific bearer. The yield for the past three years has been from 10 to 15 lb. Its season is from a week to 10 days later than Concord. It would only be recommended for jellies, etc. It is very similar in many respects to Elvira.

FAITH.—Vine, a moderate grower; shoot, 1 to 4 ft., short-jointed, not well ripened leaf, badly diseased so early as to hurt both wood and fruit. Bunch, very small. Berry, very small, white; skin, tender; pulp, sweet and rich. It is a poor bearer and is not recommended.

GOLD COIN.—Vine, a strong grower; shoot, 2 to 6 ft., rather slender, comparatively healthy; leaf, somewhat liable to downy mildew. Bunch, of medium size, open, tapering from a broad base to the tip. Berry, large, round, creamy white with a thin bloom and a few brown dots, showy, juicy, sweet, moderately rich, very good; skin, thick, tough; pulp, tender. Its season is about one week after Concord. It is a fair bearer. The yield this season was about 6 lb. The fruit adheres well to the bunch and ought to keep well. The vine is not yet old enough to have reached full bearing.

GOLDEN GEM.—A very weak grower, compact; shoot, 6 to 18 in., slender short-jointed; leaf, very small, comparatively free from disease. Bunch, very small, ragged, loose, irregular in form. Berry, small, nearly round, white or creamy white with a thin bloom, moderately juicy, slightly acid, very pleasant in taste, vinous; skin, very tender; pulp, tender, easily separated from the seeds. Season is about the same as, or later than, Concord. A very shy bearer. There seems to be no reason to recommend it.

GREEN MOUNTAIN.—Vine, a moderate grower, compact; shoot 2 to 4 ft., slender, well ripened and healthy; leaf, below medium size, light green; free from disease. Bunch, medium size, tapering from the base without distinct shoulder, well filled, regular. Berry, oval, creamy white with thin bloom and inconspicuous brown dots, moderately juicy, very sweet, rich and with a pleasant flavor; skin, thin, rather tough; pulp, tender, meaty; seeds, very small; berries hang well to the bunch, drying up without dropping off. This seems to be nearer a raisin grape than any other variety tested. It has so far been only moderately productive, but is not yet old enough to be in full bearing. Its season is nearly the same as Moore's early.

GREIN'S GOLDEN.—Vine, a rank, rather dense grower; shoot from 3 to 8 ft., close-jointed; leaf, rough, large, coarse, very free from disease. Bunch, on a long stem, above medium size to large, cylindrical, only occasionally shouldered, compact, regular. Berry, round, large, greenish white with a thin bluish white bloom, only becoming golden when over ripe, very juicy, slightly acid, pleasant, not rich; skin, very tender; pulp, tender and easily separated from the seeds; very good in quality. It is an abundant bearer. The yield the past three years has been from 10 to 14 lb. each year. Its season is from 10 to 14 days later than Concord. It sells well on account of its fine appearance, but is too tender for distant markets. This is a desirable white grape on account of its appearance and bearing quality.

F. B. HAYES.—Vine, a very moderate grower, open, healthy; wood, very firm and well-ripened; shoot, 1 to 3 ft., short-jointed, slender; leaf, healthy. Bunch, small, broader at base than apex, compact with many undeveloped berries. Berry, small to medium in size, round, creamy to greenish white with thin bloom, full of juice, rich, sweet, of very fine quality; skin, very tender; pulp, tough and hard to separate from the seeds. Its season is about the same as Concord. It is not an abundunt bearer and would be recommended for the amateur only.

JESSICA.—Vine, a moderate grower, open; shoot, 1 to 3 ft., short-jointed; wood, well ripened, stiff; leaf, below medium size, comparatively free from disease. Bunch, small, compact, oblong, or cylindrical, seldom shouldered, regular. Berry, medium, round, creamy white with a thin white bloom, numerous and conspicuous brown dots, juicy, sweetish, very pleasant, mild and agreeable, flavor, very good. The vine has produced from 6 to 8 lb. each year for the past three years. Its season is 4 to 5 days later than Concord.

LADY.—The vine is a rather weak grower and has been a light bearer. The foliage is too subject to disease. Bunch, of medium size, cylindrical, with little or no shoulder, not at all uniform in size, usually straggling. Berry, varies from small to large, round, creamy white with thin bloom and conspicuous dots. The smaller berries are seedless, sweet, very pleasant, not high flavor, not foxy; skin, tender; pulp, rather tough. Its use would be for the table. Its season is the same as the Concord. The berries do not ripen evenly on the bunch and are not good until fully ripe. It is scarcely to be recommended.

Lady Washington.—The vine has been a fair grower until the last season when it did not make a good or healthy growth. Bunch, small, broader at the base, tapering toward the point, moderately regular, open. Berry, small, round, creamy white with a thin bloom, not uniform in size, varying from ¼ to more than ½ in. in diameter; the smaller ones seedless, juicy, acid without richness; skin, tender, astringent; pulp, tender, easily separated from the seeds. This is a good bearer when in health. Its season is about one week later than Concord.

Martha.—Vine, a moderate, very open grower; shoot, 2 to 4 ft., slender, dark, almost brown; joint, long; wood, well ripened; leaf, medium size, free from disease. Bunch, large, rather open, broad at the base, tapering to the tip. Berry, medium size, round, creamy white, almost yellow when full ripe with a thin bloom and small brown dots, but little juice, very pleasant, slightly acid, very good in quality; skin, very tender; pulp, very tender, meaty, easily separated from the seeds. Its season is some later than Concord. It yields sparingly and is not recommended for the general grower.

Mason's seedling.—The vine has been a strong grower until the last year. Bunch, medium size or above, tapering from the base to the apex, fairly compact. Berry, large, round, pale, greenish white with a very thin bloom, juicy, mild, pleasant, sub-acid. not rich; skin, very tender; pulp, tough. A very good bearer. Its season is about the same as Concord. Use, table, or for jellies, etc. It would not make a market grape on account of appearance. We could not recommend it for general planting, though it stands above the average among white grapes.

Missouri Reisling.—Vine, a very rank, dense grower; shoot 4 to 10 ft , joint, long; wood, well ripened; leaf, large, dark green, coarse, free from disease. Bunch, small to medium size, usually cylindrical or oblong with a small shoulder, compact. Berry, medium to large, oval, greenish white, becomes amber when over ripe with a very thin bloom and conspicuous dots; full of juice, slightly acid, with but little richness, pleasant to the taste; skin, very tender; pulp, tender. Its season is about one week later than Concord. The yield for the past three years has been from 8 to 12 lb. It is very similar in general appearance to Elvira and Etta.

Moore's diamond.—The plant has been a good strong grower until the past season, when it made shoots of only 6 to 8 in , and looked as if about dead. Bunch, very large, shouldered, fairly compact. Berry, white or yellowish white, large, round with a thin bloom, becoming brown or blistered where exposed to the sun, juicy, sweet, mild pleasant flavor, but not rich; skin and pulp very tender. It presented the finest appearance of any of our white grapes when the vine was in good health, but its behavior the past season prevents recommending it with any degree of confidence. Its season is a little later than Concord.

Niagara.—The vine is a very strong grower and free from disease. Bunch, when fully developed, very large and well shouldered, tapering from the base to the tip and fairly compact; as grown here most bunches are not large and are very poorly filled. Berry, large, round, greenish white with a thin white bloom, almost sweet, without richness, slightly foxy; skin and pulp, very tender. This variety has been a fair bearer. The yield for the past two years has been 8 to 10 lb. Its season is 3 to 4 days later than Concord. It has not, with us, justified the claims that were made for it when it was introduced, and is not recommended for general planting.

Noah.—Vine, a very vigorous, dense grower, making an excess of wood ; exceptionally free from disease, either of the plant or fruit, and a regular and heavy bearer. Bunch, medium size, shouldered, very compact, the berries flattened against each other. Berry, large, round, pale, greenish white with a thin white bloom; juice, watery, sour without richness; skin, tender; pulp, tender when fully ripe. Its season is 3 days to a week later than Concord. Its principle use would be in making jellies. The yield for the past three years has been from 10 to 14 lb. Although a heavy bearer it is not recommended.

PEARL.—Vine, a very rank and rather dense grower; shoot, 4 to 10 ft.; most of the wood well ripened; leaf, large, rough, and comparatively free from disease. Bunch, small, to medium, not shouldered, cylindrical or oblong, compact. Berry, small to medium, round, greenish white, thin bloom and a few small brown dots, moderately juicy, sweetish, quality only fair, rather flat; skin, tender; pulp, very tender. Though the plant has not reached full bearing it would be classed as a light yielder. Its season is nearly two weeks later than Concord. From our experience it could not be recommended.

POCKLINGTON.—Vine has been until the last year a very fair grower. The leaves died and dropped some for the past two years. Bunch, medium size to large, short and thick, oblong, inclined to be irregular and not well filled. Berry, very irregular in size, often imperfectly developed, oblate, creamy white when fully ripe with russet patches and inconspicuous brown dots and thin bloom, moderately juicy; quality, moderately good; skin, very tender; pulp, tender and meaty, slightly acid and some astringency next the skin. Its season is about 4 to 5 days after Concord

PRENTISS.—Vine, a moderately vigorous grower, open; shoot, 2 to 6 ft., stout, short-jointed, downy; leaf, pale green, subject to downy mildew. Bunch, small, short and thick, tapering from the base to the apex. Berry, medium to very large, oval, greenish white to pink or light red with a thin white bloom, very juicy, an agreeable mixture of sweet and sour, without high quality; skin, very tender; pulp, somewhat stringy, but tender. Its season is late, 2 to three weeks after Concord. It has been a shy bearer. The crop for the past three years being only from 2 to 4 lb.

TRANSPARENT.—Vine, a rank grower; shoot, 4 to 12 ft.; joint, of medium length; wood, well ripened; leaf, large, smooth, comparatively free from disease. Bunch, very small, 3 in. long, cylindrical, shouldered, fairly compact, regular. Berry, small to very small, pale greenish white with a very thin bloom, so nearly transparent that the seed can be seen in outline, numerous conspicuous small brown dots, rather dry, acid without richness; skin, rather tough. thin; pulp, meaty, only moderately tender. It has been so far a shy bearer. The crop this season was about 1 lb. on a vine large and old enough to have borne 15 lb. There seems no reason for recommending it.

TRIUMPH.—Vine, a moderate, stocky, healthy grower; shoot, 2 to 5 ft.; wood, well ripened; leaf, large, dark green, free from disease. Bunch, medium size, cylindrical, shouldered. Berry, medium size, round, juicy, greenish white, thin bloom, acid without richness; skin, tough; pulp, tender. Season is about 2 weeks later than Concord. The yield the past year was about 1½ lb. There seems to be no reason to recommend it.

UHLAND.—Vine, a very rank and dense grower; shoot, 3 to 10 ft, rather slender, joint, medium length. Bunch, very small, nearly cylindrical in outline, sometimes shouldered, seldom regular, often very imperfectly filled. Berry, small, greenish white, becoming almost a creamy white with a thin bloom, pleasant without positive character; skin, tender, thin; pulp, tender, meaty, almost dry, separates easily from the seeds. Berries drop easily from the stem. A shy bearer. The yield was about 2 lb. this year and was less last. Its season is 4 to 5 days later than Concord. There seems no good reason for recommending it.

WINCHELL.—This is generally conceded to be the same as Green Mountain. While there has been some difference between them here, there has been no more than between different individuals of the same variety as grown in other parts of the vineyard.

VARIETIES THAT HAVE FAILED.

The following varieties have been practical or complete failures so far as tried here.

ADIRONDACK.—Planted in 1890, has always been a very poor grower, is nearly dead and has borne no fruit.

BLACK EAGLE.—Planted in 1890, has been a very weak grower, and, though the shoots and leaves look healthy, the plant is not so large as when first set out. It has borne no fruit.

CONCORD CHASSELAS.—Planted in 1889, has been a very weak grower and though the foliage looks healthy it has never made shoots of more than 8 inches in length. It has borne three small bunches of grapes, Bunch, small. Berry, small, white, acid, not rich. Of no value here.

CONCORD MUSCAT.—Planted in 1889, died after the first year.

CORNUCOPIA.—Planted in 1888, died before the end of the first season, and was not replaced.

CREVELING.—Planted in 1889, is a very weak grower and has not been healthy. It has borne a few berries. These were small and not of good quality.

EXCELSIOR.—One plant set in 1890 and one in 1891; both are nearly dead and have borne no fruit.

HIGHLAND.—Planted in 1890, is very nearly dead and has borne no fruit.

MERRIMAC.—Planted in 1889, has always been weak, usually dropping its leaves early, and is now nearly dead. It has borne no fruit.

MAXATAWNEY.—Planted in 1889, has always been a very weak grower, is nearly dead and has borne no fruit.

PIZZARO.—Planted in 1889, has been a very poor grower and the leaves have dropped badly. It has borne no fruit.

POUGHKEEPSIE.—The vine is no larger than when first planted in 1890. It has borne no fruit,

REBECCA.—Vine, a weak grower; shoot, slender, 1 to 3 ft. long; leaf, small, yellowish green. The plant set in 1889 bore only four berries this year and none last. Berry, white, oval, mild, pleasant; skin and pulp, tender.

TELEGRAPH.—Planted in 1890; has always been a very poor grower and the leaves subject to disease. It has borne no fruit.

WAVERLY.—Planted in 1880, made a sickly growth for two years and then died.

CONCLUSIONS.

As a result of the test of varieties here and from this general reputation as grown in other places the following recommendations would be made:

Grapes for market:

Black.—Concord, Worden, Ives Seedling.

Red.—Delaware, Lindley.

White.—Grein's golden, Niagara.

For home use—List would be nearly the same:

Black.—Concord or Worden, Moore's Early.

Red.—Delaware, Lindley, Massasoit, Brighton.

White.—Grein's golden, Elvira, Niagara, Green Mountain.

There are many other varieties that are of value and probably some that with more and wider experience would be placed above part of those named. It will be seen that most of the varieties named are by no means new. Most of the new things prove to be, *not improvements on*, but only *variations from*, *old varieties.*

G. W. McCluer, M.S.,
Assistant Horticulturist.

A GRAPE DISEASE.

In addition to the considerable number of parasitic and other of the grape diseases now well-known, there has recently been noticed upon this plant what seems to be a new disease, the cause of which has not been determined. From the descriptions published in Bulletin No. 2, Division of Vegetable Pathology, United States Department of Agriculture, upon "A California Vine Disease," it seems probable that we have here the same malady to contend with. The identification, however, has not been made by any one qualified to express an authoritative opinion.

Definite notice was first taken of the disease in the summer and fall of 1889. It was observed more on the Concord than on any other variety, probably because there are more Concords grown, than for any other reason. The trouble usually makes itself apparent about the middle of the summer. The edges of a few of the leaves, usually the older ones, are affected first. These turn yellow, then gradually die, and as the disease progresses the whole leaf and additional leaves are affected. Before the leaves are entirely dead they drop off leaving the vine more or less bare. The blade often separates from its stock, which adheres for a time to the stem. The disease or its effects have not been noticed on the stems until after the frost has killed the leaves. This is probably due to lack of sufficient observation, since but little attention has been paid to the plants from the time of the ripening of the fruit until the fall pruning, which is usually done in November. When the fruit was picked this season in September the shoots from which the leaves had fallen as a result of the disease were still alive, and unless the disease had been very bad there was nothing in their appearance to attract attention. November 10th it was found that on all plants on which leaves were badly affected a large part of the current season's growth was dead, sometimes back to the old wood, but more often with from 1 to 4 joints at the base still alive.

A vineyard of Concords, near the University farm, that has been poorly cultivated and otherwise poorly cared for, has shown the disease more than any other examined. In our own vineyard of Concords the disease was worse where the vines were not cultivated than where they were, and among the vines not cultivated it seemed worst on plants carrying the most fruit.

Ives seedling, in our vineyard of varieties, was somewhat diseased in 1892, and in 1893 the disease was so bad that three-fourths of the leaves dropped and the shoots were only 6 to 12 in. long; while in another vineyard less than one-fourth of a mile away the same variety

Varieties Showing the Disease Worst in 1892.	Varieties Showing the Disease Worst in 1893.
————	Alphonse.
————	Agawam.
————	August giant.
Beauty.	Beauty.
————	Cambridge.
Centennial.	Centennial.
————	Concord (one vine in the variety vineyard and several in the other.)
Cottage.	Cottage.
Delaware (one plant).	Delaware (one plant, but not the same as 1892.
————	Duchess.
————	Dracut amber.
————	Early victor.
Eldorado.	————
Eumelan.	————
————	Essex.
————	Faith
Grein's golden.	————
F. B. Hayes.	————
Ives seedling (2 plants).	Ives seedling (all the vines in vineyard of varieties, but none in the other.)
————	Jefferson.
————	Jewel.
Lady.	Lady.
————	Lady Washington.
————	Mason's seedling.
Mills.	Mills.
Moore's diamond.	Moore's diamond.
Moore's early (2 plants).	Moore's early (all).
————	New Haven.
————	Norfolk.
Norwood.	————
————	Oneida.
Pocklington.	Pocklington.
————	Rochester.
Telegraph.	Telegraph.
————	Uhland.
————	Vergennes.
————	White Hall.
————	Woodruff red.
Transparent.	————
Wyoming red (2 plants).	Wyoming red (2 plants).

was entirely exempt. The latter vineyard is on level land, though not low. The former is on comparatively high and well drained land. Both were kept well cultivated and were otherwise well cared for.

As noted before on page 250 one Delaware vine that was diseased in 1892 seemed healthy the next year. Some of our Concords that were badly diseased in 1891 were comparatively healthy in 1892, but were again more or less affected the past season. Whether the vines in our variety vineyard which have shed their leaves so much for the past year or two will recover and be again as good as ever remains to be seen. The varieties worst diseased in 1892 and in 1893 are arranged on p. 269 in parallel columns for comparison. It will be seen that there are more the last year, but that a few of those noted as being badly diseased in 1892 are not in the list for 1893.

G. W. McCluer, M.S.,
Assistant Horticulturist.

GRAPES, METHODS OF TRAINING.

In 1888 six rows of grapes were planted with a view to trying the comparative merits of some of the more simple methods of training grapes.

There were eight plants and five different varieties in each row. The varieties were Concord, Worden, Moore's early, Ives seedling and Delaware. The methods of training used have not been so varied yet as at first planned, and the results obtained have not been by any means exact.

The rows of grapes run north and south and the vines are ten feet apart in the row. The first row is trained on a horizontal trellis; the second, on a single wire; the third, on an ordinary three wire trellis with a roof of boards over it; the fourth and fifth, on a three-wire trellis; and the sixth is trained to stakes. The horizontal trellis is 3½ ft. from the ground, made by putting cross-bars two feet long on posts 3½ ft. high and then stretching three wires, one of which is fastened to the posts and the others to the ends of the cross-bars. The single wire is 3½ ft. high. The wires of the third, fourth and fifth rows are 2, 3½ and 5 ft. respectively from the ground. The roof of boards consists of a V-shaped trough made of 12 in. boards inverted over the trellis and making a roof of 20 in. wide. The thought in using the roof was that it would keep off rain and dew, and to a great extent stop the growth of the fungus which causes the black rot. The stakes in row 6 are five feet high. The method of pruning has been as nearly the same for all methods of training as it was possible to make it, and there has been no practical difference so far as the grapes on trellis are concerned; but those on stakes have necessarily been trimmed closer, usually not more than half so much bearing wood being left to each vine as there was on the trellised rows. On the horizontal trellis there has been for three years one cane or branch of the vine run each way on each wire. On the single wire there have been two canes or branches each way, and on the upright trellises there have usually been three branches running each way, one on each wire.

From the location of the vineyard near a prominent roadway it has been impracticable to do more than estimate the yields without taking off the fruit while it was yet green, and that was not done. Taking the estimates, the Concord has done decidedly the best on the three-wire horizontal trellis and poorest on the stakes, the yield for three years on the horizontal trellis being, for the single vine, from 24 to 33 lb. each year, while the two vines on stakes gave about 5 to 8 lb. each during the same time. Concord, as well as all the rest, under the roof of boards has decayed comparatively less than on check row without the cover; but the branches have almost invariably been much inferior in size and very poorly filled. The two vines on the single wire have produced 12 to 20 lb. and one vine on the upright, three-wire trellis has yielded about the same. The yield of two vines under cover has been from 10 to 12 lb. each year.

The grapes planted for Worden have been taken out and new ones put in their place, because it is thought they were nearly all Concords.

Moore's early has done best on the three-wire horizontal trellis; next best on the three-wire upright trellis; next on the single wire; next on the covered trellis, and poorest on stakes.

Ives seedling has seemed to do a trifle better on the upright trellis; next best on the horizontal trellis; next on the single wire; next under cover; and poorest on stakes.

Delaware the past year has been perhaps somewhat better on a horizontal trellis; but the two years before it seemed to do rather better on the upright trellis. Taking the last three years together there has been practically no difference in this variety between the two methods of training. The single wire trellis gave the next best results; covered trellis next; and stakes again the poorest.

Taking the five varieties as a whole they have done best on the horizontal trellis, though there has not been much difference between that and the upright three-wire trellis except with Concord.

The vines on stakes have uniformly made the poorest growth and given the smallest yield.

The grapes on the covered trellis have rotted less than those on a row beside it, not covered, but it has also yielded considerably less from a failure of the fruit to set.

Grapes are more easily trained on trellises than on stakes and as the vine does not make such a compact mass on the trellis it is much easier to get at the fruit either in spraying or harvesting.

While there has been no chance to make a comparison of different heights for the horizontal trellis, ours seem to be too low for the greatest convenience. It is found easier to pick the fruit by getting under the trellis than by standing at one side of it, because the branches all hang down and are in plain sight from below.

All communications intended for the Station should be addressed, not to any person, but to the

AGRICULTURAL EXPERIMENT STATION, CHAMPAIGN, ILLINOIS.

The bulletins of the Experiment Station will be sent free of all charges to persons engaged in farming who may request that they be sent.

G. W. McCLUER, M.S.,
Assistant Horticulturist.

UNIVERSITY OF ILLINOIS,

Agricultural Experiment Station.

CHAMPAIGN, DECEMBER, 1893.

BULLETIN NO. 29.

CONTENTS—ORANGE RUST IN RASPBERRIES AND BLACKBERRIES.
A NEW FACTOR IN SCIENTIFIC AGRICULTURE.

*ORANGE RUST OF RASPBERRY AND BLACKBERRY.

For the past twenty-five years notes have appeared in various agricultural and horticultural publications of this country of a fungus occurring on raspberries and blackberries, which, on account of the bright orange colored spores produced on the leaves, has been uniformly known as "orange rust." So marked and so persistent is the action upon these berry plants, its "hosts," of this lowly organized parasitic plant that it is recognized as one of the most destructive of what are known as parasitic fungi.

To botanists this fungus has been known since the earlier part of the present century, when it was first mentioned as occurring in Kamtchatka, and soon after, in Carolina of this country. A glance at "Distribution" in the Appendix shows that it is quite widely spread over the eastern part of the United States. In some localities, however, it is much more abundant than in others. Mention of it has not been found as occurring further west than Nebraska, and Dr. Harkness, in a letter,

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*The writer wishes to acknowledge his indebtedness to Professor Burrill, who first suggested the possible relationship of *Caeoma nitens* and *Puccinia Peckiana*, and at whose suggestion the investigation of their life histories was undertaken. To various botanists who have responded to our letters of inquiry, thanks are also due. Reference to articles is made in the text by giving author's name and date of publication; but such references may be found more fully given under "Literature," in the Appendix. After the above paper had been written for publication, an article by Tranzschel, published in *Hedwigia*, was received. By artificial infection, this writer so completely verifies the results that we have obtained that his experiments have been added to the paper, and proper credit has been given.

states that he has never collected it in California. It is not at all improbable, however, that it may be found further west. Reports give it as occurring in our most southern states, and from them it extends beyond our northern limits into Canada. In Europe and Asia, while not so numerously reported, it has been found over a large range of territory and is said to be quite common in some of the northern stations.

So far as known this fungus has limited its ravages to the genus Rubus. Both cultivated and wild species are freely attacked, and of the former quite a number of varieties have been reported as more or less injured, of which the Kittatinny is perhaps one of the worst affected. In this region the Snyder seems usually to be quite exempt from attack, although elsewhere reported as more or less infected. In the Appendix is given a list of species so far found to be attacked.

The fungus shows its first signs of appearance in early spring, varying slightly in time as the weather is favorable or not to the growth of its host. In this locality it can first be detected during the latter part of April or the first of May. As soon as the leaves are fairly started in their development, and before they are unfolded, what is known as the spermagonial stage can be seen. The spermagonia resemble small stalked glands thickly covering both sides of the leaf, and at first are so deceiving in their appearance as to be mistaken for glands naturally belonging to the leaf. As the leaves mature, the spermagonia become more distinct, and while usually found covering the leaves of the affected plant, are sometimes variously limited in their distribution. Some leaves, usually the upper, may be affected, and others entirely free; even some of the leaflets of a single leaf may show this stage while others do not. Nor is it an uncommon occurrence to find definitely affected patches of an individual leaflet sharply marked off from the remaining apparently healthy parts. About two or three weeks after the first appearance of the spermagonia, the second, or aecidium stage becomes noticeable, showing as concealed, slightly elevated spots thickly covering the under surface of the leaf. The rapid growth of these soon ruptures the epidermis above each bed of spores, and they then show as bright orange colored masses. About this time the spermagonia have reached their maximum development. So far as observed the aecidium stage is limited to those leaves or parts of the leaf that were affected by the spermagonia, although all parts affected with spermagonia do not necessarily produce the former. The aecidium stage is confined almost entirely to the lower surface of the leaf, rarely slightly affecting the margin on the upper side. It is also found, in rare cases, on the stems. It reaches its maximum development here during the first part of June, and during the latter part of the month gradually disappears until only isolated cases can rarely be found during the first of July. Some writers mention it as occurring again during the autumn months. Brunk (1890) claims to have found it in Maryland as late as the middle of October, and writes that in the extreme southern states he has found specimens in

December. It has been found by the writer during the spring and early summer only.

The fungus is found on the leaves of old and new shoots, and is usually so vigorous in its spore development that it utterly destroys the usefulness of the affected leaves. These fall off in time, and if the fungus has not so far impaired the vitality of the plant as to prevent further development, the subsequent growth of branches with unaffected leaves may help repair the damage. Frequently, however, especially in young shoots, the canes, stripped of their leaves, hindered in growth, fail to overcome the damage, and so die. Since it is also a fact that a plant once infected is quite certain of attack each succeeding year, it is usually only a matter of time before the most vigorous of plants are rendered worthless. Sometimes the presence of only the spermagonial stage is sufficient seriously to affect the efficiency of young shoots. Horticultural papers sometimes contain notices of localities in which blackberries and raspberries in general are so seriously affected by this disease as to render their cultivation unprofitable, if not impossible. The same plants or patches being annually subject to attack early led many to suppose that the fungus must be perennial in its host, a fact which was first publicly demonstrated by Newcombe (1891), who found mycelium in microscopical sections taken from different parts of affected plants.

This perennial nature of the fungus makes successful prevention of the disease exceedingly difficult. Various methods of treatment have been made, of which probably only one has given any uniformly good results, that of digging up and destroying all affected plants as soon as signs of disease were manifested. Spraying has been tried to see if any good could be accomplished. With the mycelium perennial in the host, the good in this case must be in preventing the spread of the disease to unaffected plants, and then only under conditions depending upon the life history of the fungus. If the aecidiospores germinate upon the leaves of Rubus to produce another stage of development, then spraying at the proper season should be beneficial in this direction. As the indications are that the above supposition is correct, spraying with Bordeaux mixture as soon as the aecidiospores begin to show, preceded by a thorough cutting out of plants as soon as signs of the disease are manifested, should, in a few seasons, eradicate this disease. As the spores in germination seem to gain entrance on the under side of the leaf, it would be especially necessary in spraying to wet that side. The fungus has also some natural enemies that are of slight use in destroying its spores. Among these may be mentioned the larvae of certain insects, which feed quite greedily on the spores, and *Tuberculina persicina*, a fungus which occurs frequently as a parasite on the sori.

Having stated that a plant once attacked by this disease is perennially subject to it, let us see why this is so. This will lead us to consider the vegetative stage of the fungus, or what is technically known as the mycelium.

MYCELIUM.

The bright, orange colored patches on the under side of the leaves are made up entirely of spores, or the reproductive part of the fungus. To produce these there must be a vegetative system; just as to produce the fruit of the blackberry there must be the root, the stem, and the leaf. This vegetative, or mycelial stage is concealed entirely within the plant, and in this fungus, contrary to the usual rule of its family, is quite extensively developed. To show this, microscopical sections of the affected plants are necessary. From those made of variously affected parts the following facts have been learned concerning this stage of the fungus: Such sections reveal mycelial threads present from the upper parts of the roots running through the stem up into the uppermost leaves showing signs of affection. That is, we may take any affected leaf, make sections of its blade, its petiole, the junction of petiole to branch or main shoot, and so down the stem to the perennial part, and even somewhat into the root itself, and in all the sections find the mycelium. Frequently plants are found in which the new shoots are affected but the old ones are free. In such cases the mycelium is found in the former only. The canes of raspberries and blackberries are biennial, and, so far as personal inspection goes, unless these are infected during their first year they can not be the second; and if they are affected the first year, they are quite sure to be the next. This is easily explained by the fact that the mycelium follows young growing cells, and cannot penetrate tissue to any extent after it has matured. Sections of very young canes of the diseased plants show that they contain mycelium, and that in such it follows quite closely the point of growth. In such sections, fungus threads have been traced from the stem into the scale-like leaves protecting it, and into the ordinary leaves before they have become differentiated into blade and petiole. Sections of roots, except in the neighborhood of the merging of root and stem, do not show the mycelium. Now, from the above, one can see how a single plant can have both new and old stems affected and free, illustrations of which are sometimes met. In such a case the unaffected canes come from underground parts into which the mycelium failed to penetrate when they were young, and so was shut out; and the affected ones come from where the mycelium had gained entrance. The above facts also prove that the first infection of a plant must be through the shoots when very young and easy of penetration. The plants present this condition during late fall and early spring. As illustrating the perennial nature of the fungus, and method of infection, the following experiment is given: In 1892 eighteen plants were marked, of which ten were affected with this Caeoma and eight were free. In 1893 these were examined again, and the ten diseased in 1892 were found to be in the same condition, and the eight healthy ones of the year before were so still, except in one case. This plant was affected only on the new, very young canes, showing that through them the fungus gained entrance.

The structure of this vegetative stage, when examined, is found to consist of two parts—mycelial threads and haustoria. The function of the former is, evidently, to carry the fungus to different parts of the plant; and so the threads are found between the cell walls, quite often in the spaces where three or more cells come together. In transverse sections of the plant these show as cut ends, while in longitudinal sections they can frequently be traced for quite a distance. In such cases they appear as hyaline filaments of varying diameter, having definite cell walls, and, according to age, more or less protoplasm. From these spring the haustoria, similar but very short threads. The haustorium pierces the cell wall by a narrow neck and inside the cell enlarges into a body with a more or less knobbed end, the function of an haustorium being to supply nourishment necessary for the growth of the mycelium. The fungus filaments are not found distributed irregularly through the plant, but are limited to certain localities. In the root and root-like part they are found between the parenchyma cells of the cortex in the vicinity of the cambium. The abundance of starch in these cells makes it necessary that very thin sections be made, which show best when stained with an alcoholic solution of potassium iodide and iodine, thereby coloring the starch grains blue and the fungus a yellowish green. In cells containing haustoria their effect upon the amount of starch in very evident (*Plate 3, fig. 12*). As a rule, in this part of the plant, the largest and most knobbed of the haustoria have been found. In the stems the mycelium is found in the pith, mostly between the smaller cells near the fibro-vascular bundles. The leaves have the mycelium entering them when quite young, and the interstices of the parenchyma cells afford its abode. In young shoots the mycelium is not so limited to particular localities, occurring occasionally among the parenchyma cells of the bark, and even among the outermost cells of the bundles not yet fully developed.

The appearance of the mycelium depends somewhat on its age. When young it is more conspicuous, but when old it loses its protoplasm and acquires an occasional septum. The haustoria are at first simple threads extending half way or more across the cell. They soon begin, by coiling or twisting, to form an enlarged, knotted end. This possibly may be due to the effort of the haustorium to come into more intimate contact with its food particles. Sometimes two haustoria are found in the same cell, and not infrequently have there been seen signs of union of these (*Plate 3, fig. 3, 4, 7*). This, however, is to be interpreted as nothing more than an accidental occurrence.

Late in April a more conspicuous gathering of mycelium in special places just beneath the epidermis of the leaves is noticeable, and then begins the formation of the first fruiting stage of the fungus, or the spermagonia.

Spermagonia.

Transverse sections through one of these mycelial groups at this time show the threads as an indefinite mass chiefly in cross section. The threads begin to grow upward between the lateral union of contiguous epidermal cells, forcing the cells apart and upward as a slight papilla. Sections now show the mycelium in these papillae more in longitudinal view as closely packed, septate threads, and the epidermis above the infected spot is seen as two large cells, forced above the level of the surrounding cells at their juncture with each other, and separated from each other at their bases by the intervening mass of mycelium (*Plate 2*, *fig. 1*, *2*). According to Richards (1893) further growth so pushes against the interior walls of these elevated cells as to cause them to collapse, and the cells become filled with mycelium. The upright threads, so closely crowded together as to form a sort of false tissue, having reached their growth, begin to cut off from their upper free ends numerous small oval bodies. These are known as spermatia, and when entirely formed occupy about the upper third of the spermagonium. When they have been formed in sufficient numbers, the epidermal covering becomes punctured, and they ooze out on the exterior of the leaf as a small viscid drop.

The function of these spore-like bodies is not definitely known. Some botanists consider such as male elements concerned in the fertilization of the aecidium stage of fungi. The function of somewhat similar bodies found in lichens has led to this view, and, while rather generally accepted, there seems to be no direct evidence that these so-called spermatia are really such. Some have thought that these bodies effect fertilization of the mycelium, while others have held that each aecidiospore may be fertilized by a spermatium, as spermatia are frequently seen adhering to the spores. The fact that spermagonia are generally produced with the aecidium stage, and that both are borne on the same mycelium suggests, at least, intimate relationship. Other botanists have discarded the idea that these were at all sexual elements, and declare that they are merely conidial stages of the fungus, and that the so-called spermatia are conidiospores. Plowright, holding this view, claims to have produced a yeast-like germination of these bodies in sweetened water. A similar germination was also previously claimed by Cornu. In culture experiments with the spermatia of this fungus, such a method of reproduction has been noticed, but satisfaction was not had that such did not contain yeast fungi. The chief objection to the view that these are conidial bodies is the special use they could have, since they are generally produced in connection with the aecidium stage whose spores have an almost similar function. Winter merely says that the physiological significance of the spermatia is not yet surely made out. Be their use what it may, about the time of their maximum development the signs of a second spore stage become visible to the naked eye.

Caeoma, or Aecidium Stage.

This, known as "orange rust," is the most conspicuous stage, on account of being seen externally and because of the bright color of the spores. Like the spermagonia, it has its origin in the mycelium of the leaf, only this time the mycelium begins to form in masses on the lower side of the leaf. Here is produced a more extended development of filaments. From these arises a compact mass of threads divided with septa, in a basipetal manner, into distinct cells. The distal cells gradually become rounded at their septal unions, and are less securely fastened together. Their walls also become minutely verruculose, and, though hyaline, are given an apparent color by the endochrome which with the protoplasm fills the cell. The aecidiospores thus mature, and separate into distinct bodies. These being formed now just beneath the epidermis, the strain on it becomes too great and a rupture takes place. The epidermis above the sorus soon wears away and the golden spot, until now seen indefinitely through the epidermis, shows as bright orange. The spores when fully matured vary from elliptical or oblong to subglobose, and usually measure 12 to 24 by 18 to 32 microns. Their thin, hyaline exospore is finely covered with minute tubercules. Their orange color is due to the presence of a considerable amount of endochrome.

If, soon after these spores are mature, they are put in a moist place germination takes place. In watching this under the microscope, the following has been found most useful: A glass ring, the diameter of the cover glass and about a quarter of an inch high, is fastened to the glass slip by means of vaseline. In a drop of sterilized water on the cover glass are dusted a few of the mature spores. This is inverted and fastened on the top of the ring by means of vaseline previously placed on its edges. If for any reason one finds the water drop too deep for focusing on its free surface, this can be prevented by washing the cover before use with caustic potash. Cultures thus made can be examined through all stages of spore germination without fear of evaporation. Mature, fresh spores often show signs of germination within three hours after being placed in water. The first sign is a small swelling appearing on the side of the spore. The contents of the spore, surrounded by the endospore, have pierced the exospore through a small opening, and have swollen into a small hyaline body. This gradually lengthens by apical growth into filamentous form, and then the endochrome appears in the tube as small colored globules. The growth of the tube is about the same for eight or ten hours, when it has reached a length three or four times the diameter of the spore. All this time the protoplasm has been disappearing from the spore and entering the germ tube. The protoplasm of the spore at first becomes less dense, then vacuoles appear, and the contents are gradually limited to the region of the germ pore.

The spore is thus emptied in about eight hours, but the germ tube keeps on growing, and gradually becomes empty at its base. As the protoplasm recedes from the lower part of the tube, an occasional septum may be formed. Growth is practically stopped only by the exhaustion of the protoplasm, and usually lasts for two or three days after the first signs of germination, the length of the tubes at this period frequently being eight or more times the diameter of the spore. The germ tubes are mostly of a uniform diameter, with the tips sometimes slightly narrowed. They usually present a slightly flexuous, rather than a rigid, straight growth. Upon some occasions movement of the protoplasmic granules can be seen in the germ tubes. Occasionally germination presents anomalies in the shape of suddenly enlarged or of flexuous tips, and in a single case branching has been seen, but never more than a single developed germ tube has been found to a spore.

Such being the characters presented in artificial germination, in what manner should we expect these spores to act when infecting their hosts? Botanists have proved that such summer spores gain entrance into plants by the growth of the germ tubes into the stomates of the epidermis and so into the parenchyma tissue of the leaves. This being the case it is left for decision whether with these germinating spores the blackberry and raspberry leaves are used for further development, or whether, as is so often the case, some other entirely different plants have been chosen. The indications being that the former was the case, artificial growth on the leaves was undertaken. In both raspberry and blackberry, the stomates are almost entirely confined to the under side of the leaf, some few being found on the margins of the upper side. In the former, too, the lower surface is so covered by hairs as to afford considerable difficulty in examining the epidermis. So blackberry leaves on a small shoot were moistened on their lower surface and then dusted with spores. The shoot was then placed in a moist chamber and left for twenty-four hours. Examination of the leaves was then made under the microscope. The epidermis of these leaves sticks so closely to the parenchyma cells that it cannot be satisfactorily removed. The leaf itself is too opaque for examination under high powers. It was necessary, therefore, carefully to soak pieces of the leaf in hot caustic potash, wash, and squeeze slightly under the cover glass before the surface of the epidermis could be examined. Such a process, however, is likely to wash off any spores that may be on the surface of the leaf. Under such circumstances were found, on one occasion, spores that showed signs of entering the stomates (*Plate 4, fig. 22*). These spores presented characters never seen in mere water cultures; for, after they had sent out an ordinary tube about three times the diameter of the spore, it suddenly became considerably narrowed; and in several cases this narrowed part was found between the guard cells of the stomates, showing, at least, that the fungus could gain entrance in this way. No germ tubes were ever found piercing through the epidermis itself. The experiment of inoculating a healthy plant, kept indoors, was also tried; but as about the time results from this could be expected the plant died, evidence in either direction was wanting.

Since these spores germinate readily as soon as mature, and probably infect blackberries and raspberries through their leaves, it might seem that they were means of spreading the aecidium stage from plant to plant. But when we consider that this stage is limited to spring and that no plant or parts of a plant become diseased except those early showing its signs, such an inference becomes impossible, and we are led to inquire to what does this stage give rise? This brings to our consideration what is known as alternation of spore forms.

Alternation of Spore Forms.

The fact that the aecidiospores soon lose their power of germination, coupled with the knowledge that such spores have been proved in numerous cases to be merely summer stages of more advanced forms, has suggested, with almost certainty, that this fungus has other spore stages in its life history not now recognized as belonging to it. Botanists have, therefore, suggested different forms as the mature stage, basing their opinions on more or less superficial observations. Let us see what evidence there is that such are advanced stages of this fungus.

Melampsora. Dietel gives the following species of Melampsora and Caeoma that different investigators have connected with each other by culture experiments.

Melampsora Salicis capreae, (Pers.) and *Caeoma Euonymi*, (Gmel.) —Rostrup.
Melampsora Hartigii, (Thüm.) and *Caeoma Ribesii*, Lk.—Rostrup.
Melampsora aecidioides, (DC.) and *Caeoma Mercurialis*, (Pers.) —Plowright.
Melampsora Tremulae, Tul. and { *Caeoma Mercurialis*, (Pers.) / *Caeoma pinitorquum*, A. Br. } —Rostrup.
Melampsora Tremulae, Tul. and *Caeoma Laricis*, (Westd.)—Hartig.
Melampsora Populina, Jacq. and *Caeoma Laricis*, (Westd.)--Hartig.

Plowright also made cultures to duplicate the above results, but was successful in only the case attributed to him. These results indicate a close relationship between Melampsora and Caeoma, and suggest that the mature form of the Caeoma we are considering might be found among the species of Melampsora. So far as is known no culture experiments have been made along this line. The fact that this Caeoma is so common would indicate that the teleutoform was not rare, and this again would suggest the Melampsora on Populus or Salix as the most probable one; but, apparently, the above investigators have found both of these species connected with entirely different species of Caeoma. Rathay also claims to have found *Melampsora populina* as connected with *Aecidium clematidis*, and this, taken with other conflicting results in the above list, makes it quite improbable that all species of Caeoma will be found connected with Melampsora as the mature stage.

Phragmidium. Another genus with which some botanists have suggested connection with this Caeoma is Phragmidium, especially with the species *Ph. Rubi.* The facts that in this genus all three spore forms may occur on the same host species, and that in some, *Ph. mucronatum*, the aecidium stage has gross resemblance to *C. nitens*, together with the further facts that *Ph. Rubi* and *C. nitens* are found on the same hosts and frequently in the same localities, seem to be the chief points in favor of considering them as forms of the same thing. Perhaps, too, the fact that the aecidium form of *Ph. Rubi* is wanting or little known in some localities has had much to do with suggesting the connection. These, however, are too general points to be of definite value in proving connection of the forms. Let us see what more specific points will indicate. As to structure, we find some difference between the ordinary aecidium stage of Phragmidium and this Caeoma, for in the former paraphyses surrounding the sori are characteristic, while in the latter there is no evidence of them. We find no recorded cases of both forms occurring commonly on the same individual host, as one might expect if they were related. Then, in this locality at least, the failure to find this Caeoma after the first of July, while the collections of *Ph. Rubi* have not been made earlier than September, is also against their connection, as two months between the disappearance of an aecidium and the appearance of an uredo form is too long a time for which to account. Lastly, most European botanists have considered this Caeoma as distinct from the Phragmidium, especially since Krieger has found and described an aecidium form that corresponds to the normal type of such stages of Phragmidium, and which is now accepted as the first stage of *Ph. Rubi.* Since the aecidium and uredo forms of Phragmidium are frequently so similar, it is not at all unlikely that in this country the earlier stages of *Ph. Rubi* have occasionally been classed indefinitely under the uredo form.

Puccinia. Still another genus, Puccinia, has been named as having connection with *C. nitens.* In 1885 Burrill suggested that a relationship might exist between *Caeoma nitens* and *Puccinia Peckiana*, as both were found in Illinois on the same hosts. Our study of these fungi has led to the belief that this is the most probable explanation. Let us see what is the life history of the latter fungus, and then determine what evidence there is to offer it as the mature form of the Caeoma.

In this vicinity the fungus, *P. Peckiana*, makes its appearance on leaves of raspberry and blackberry about the first of July, and has been collected on them as late as September. While the fungus usually occurs on the under side of the leaf, an occasional sorus is found on the margin of the upper surface. The sori are so small as generally to escape attention when the leaf is not badly affected, and sometimes are to be recognized only by aid of a magnifier. They frequently occur in small, isolated clusters, but often the leaf is abundantly covered with them, and then the peculiar mottled green and yellow appearance of the upper surface serves as a ready aid of detection to the trained eye. Cross sections of affected leaves show mycelium in different parts running between the parenchyma cells, but much more abundant toward the lower surface. Plants known never to have been affected with the Caeoma show mycelium confined to the leaf. The mycelium gives rise directly to the teleutospores; and, so far, these only have been found. They are formed in the usual method: by accumulation of mycelium near the under surface; formation of erect, fertile branches; differentiation into spores; and eventual rupture by these of the epidermis. The mature spores are quite characteristic in their appearance. They reach an average size of 22 to 27 by 36 to 45 microns. The cell walls are of a reddish brown color, and of nearly uniform thickness. The spores vary considerably as to shape, especially as the front and side views of the same spore are not exactly the same. Usually, however, the apical cell is somewhat triangular, with apex covered with several hyaline papillae. Occasionally these papillae have been seen sparsely covering the whole cell. The basal cell is frequently quadrangular, with the short, hyaline, fugacious pedicle at one corner and the other formed by a few hyaline papillae.

Attempts at germination of these spores have been made at various times of the year, except in spring, but were successful only on one occasion. About the middle of September lately gathered spores were placed in water, and, failing to show signs of germination at the end of the third day, the slide was laid aside and not examined until the spores had been a week in the water. It was then found that a few spores had sent out germ tubes (*Plate 4, fig. 24–29*). The endospore pierced the exospore through a small opening, and immediately enlarged into the natural diameter of the promycelium. Apical growth of this took place until it had reached a length two or three times the diameter of the spore. This was about sufficient to empty the cell of its contents. Both apical and basal cells were found to germinate, though but a single tube was produced from a cell, and no example was found of both cells of the same spore germinating. The germination ceased before there was any evidence of the formation of promycelial spores. The germination of the spores at this time of the year suggests that they infect their host through some other place than the leaves.

So much for the life history of this fungus, but how may the phenomena it presents, together with those of the Caeoma, be interpreted? These will be considered in the following paragraphs on Distribution, Hosts, Life Histories, and Artificial Infection.

Distribution. While the distribution of this Puccinia has not been apparently so widespread, or so frequently reported as in the case of the Caeoma, still it has been found in the same regions only with the latter. Under "Hosts" of the Appendix are given the localities in which these have been found. The effect of the former on its hosts is so inconspicuous, especially when compared with that of the latter, that there is no doubt that its range will be more widely extended when a careful search is made for it. This conclusion is based on experience in this locality; for, while here the Caeoma had always been considered common, the Puccinia was not, until a careful search revealed it to be at least as common, if not more so, than the former fungus. In five localities watched during the past three years both forms have appeared abundantly.

Hosts. Naturally enough, the Puccinia having been less frequently seen, the number of host species it occupies will be found to be less, as is shown in the Appendix; but such as it does attack are the same as those upon which the Caeoma occurs. Until recently only one was reported from Europe, but it is the same as that upon which the Caeoma was first reported over seventy years ago. In this vicinity they leave the same host species exactly, and on the cultivated plants both have been found on the variety known as the Kittatiny. In a patch of these affected with both forms, neither was seen on an occasional Snyder growing there. Not only are they found occurring in the same locality and on the same species, but the writer has recorded hundreds of examples where they occurred on the same individual. This is forcibly shown by an experiment, given in detail in the Appendix, to determine if they were common on the same individual. In early May, as soon as the spermagonia began to show, all the affected plants were marked in a place about two rods wide and twenty long. Later, in June, when the aecidium form began to appear, these thirty-four plants were again examined and it was found that all had developed the aecidium stage. In July, they were examined a third time, and *Puccinia Peckiana* was found on all except two or three plants; that is, about 90 per cent were affected. In these exceptions the lower leaves, those most likely to become affected, had all dropped off. As some might think that the occurrence of the Caeoma and the Puccinia on the same plant was accidental, a check was had by examining for the Puccinia plants not affected by the Caeoma. Such plants of course would not be so likely to become infected unless they were close to those affected by the Caeoma. These twenty plants were chosen at random from those near and away from the marked plants. Of these, thirteen were free, and seven affected, or 65 per cent free. The seven having the Puccinia were all within three feet of plants affected with the Caeoma; while of those free, ten were from one to several rods from the nearest marked plant. Cases have also been found in which the same leaf had sori of both not the twentieth of an inch apart (*Plate 1*, *fig. 2*). The fact that the Puccinia is not uniformly found with the Caeoma is easily explained. The two forms are produced from entirely different myceliums, and as the aecidium form is so destructive to the leaves it attacks, they are frequently destroyed and have fallen off before the time of appearance of the teleutoform.

Life Histories. Another thing that forcibly strikes one as to the connection of these fungi is their time occurrence. The Caeoma, abundantly producing spores during June, gradually disappears just as the Puccinia begins to appear on the same hosts in early July. As the aecidiospores, though germinating abundantly, do not produce the aecidium stage, what could be more natural than that mature spore forms, occurring on the same hosts and at the proper interval of time, should be connected with them? Again, what other influence can be had when the Puccinia spores are found mostly on the lower leaves, where the aecidiospores can best fall from the affected leaves above? We have found several cases of a leaf unusually affected by Puccinia that was just beneath a Caeoma infected leaf. Again, these aecidiospores gain entrance into their host through the stomates, and, as our culture experiments indicate, through those of Rubus; the stomates of our raspberries and blackberries are found on the under side and margins of the upper side of the leaves; the Puccinia sori are found only in these places. But if the germ tubes of the aecidiospores enter through the stomates and these are on the under side, what avail is it even if the Caeoma affected leaves are above? The Caeoma affects the earliest leaves. Many leaves on lower, unaffected branches are beginning to unfold when these aecidiospores are mature. These young leaves are folded together conduplicately, usually with the margins upward. The lower surface is thus exposed and is not yet well protected by hairs. This is undoubtedly the time when most of the leaves are entered by the Puccinia producing agent, a fact that is further emphasized when we find that leaves of the raspberry affected by the Puccinia are not usually so hairy beneath as those that are free. The production of these hairs has been lessened by the presence of the fungus in the leaf tissues, and to effect this the leaf must have become infected before the hairs were fully developed. In examining the epidermis of leaves at about the time the Puccinia began to appear, threads of mycelium could frequently be seen beneath the stomates, and in a few cases what looked like the broken end of an upright thread seemed to be coming up between the guard cells (*Plate 4, fig. 30*). We have, however, never been able to trace this to an aecidiospore. Lastly, the Puccinia spores germinating in fall, possibly in spring also, when infection of mature leaves would be useless and when the young underground sprouts are in condition for infection, seems to indicate that the Puccinia enters the plant through these underground parts. Since the spores of the Puccinia fall off from the leaf very easily, it being impossible to find them on old leaves in spring, the spores might very easily be washed down against the young shoots. But if the sporidia of the Puccinia stage enter these young shoots or their parts they do not give rise to the Puccinia producing mycelium, for this is limited to the leaves. Why not, then, give rise to the mycelium of this Caeoma?

Artificial Infection. But after all, the chief proof of connection of two forms is by artificially producing the one from the other. Our experiments along this line have been fewer and unsatisfactory. The plants to be experimented with were transplanted in spring and died before inoculation could be made, or before time for judging of its effects. It is hoped to continue experiments in this direction. What one might call natural infection seems to be furnished by those examples where badly Puccinia affected leaves appeared just beneath a Caeoma infected leaf. However, this weak point in our evidence is strengthened by the experiments of Tranzschel (1893), whose article came to hand after this paper had been written, but the results of whose experiments are appended to this paragraph. In 1892 and 1893 he undertook infection of plants of *Rubus Saxatilis* with the aecidiospores of *Caeoma nitens.* His experiments were carried on at the botanical gardens of the University of St. Petersburg. June 18, 1893, plants both in and out of doors had the spores placed on the leaves of their young shoots, and the 12th of July the first teleutospores of *Puccinia Peckiana* were found on the plant kept indoors. The next day they were found on one of the two plants placed outdoors, and by the 24th the plants experimented with had a number of leaves badly affected. He also reports that in one locality especially examined the Puccinia was common on plants previously affected with the aecidium stage of the Caeoma.

CONCLUSIONS.

From what has been presented, the following conclusions may be given:

1. The so called *Caeoma nitens*, a widespread and very destructive fungus of raspberries and blackberries, has been proved to possess a perennial mycelium, which probably first gains entrance into its hosts through very young underground shoots.

2. This mycelium, following the growing parts of the plant, in early spring, gives rise to spermagonial, and soon after to aecidium stages, the function of the former being as yet unproved.

3. The aecidiospores, by immediate germination, give rise to a more mature spore form, which is in no way connected with the original mycelium.

4. These aecidiospores produce this form by infecting the host through the stomates of the leaves, and evidence now proves *Rubus* as the host infected, and *Puccinia Peckiana* as the teleutoform thus produced.

5. *Puccinia Peckiana*, produced on the under side of leaves of raspberry and blackberry, germinates its spores in the fall, and possibly in early spring, and probably enters its hosts through young underground shoots.

6. The two facts that the mycelium of the Puccinia is limited to the leaves, and that the mycelium of the Caeoma is found throughout the plant suggest that the mycelium of the aecidium stage has its origin from the germinating Puccinia spores.

APPENDIX.

NOMENCLATURE.

*1820, *Caeoma interstitiale,* Schlechtendal. Horae physicae Berolinenses, p. 96.

1822, *Aecidium nitens*, Schweinitz. Synop. Fungi Car., p. 69, n. 458.

1825, *Caeoma* (*Aecidium*) *luminatum*, Link. In Species Plantarum, T. VI, P. II, p. 61, n. 166.

1825, *Caeoma interstitiale.* Link in Species Plantarum, T. VI, P. II, p. 32, n. 89.

1827, *Uredo interstitialis*, Schl. Sprengel in Systema vegetabilium, V. IV, p. 574.

1831, *Caeoma* (*Aecidium*) *luminatum,* Schweinitz. North American Fungi, p. 293, n. 2887. Printed in 1834.

*1859, *Uredo lucida,* Dietrich. Blicke in die Cryptogamenwelt der Ostseeprovinzen, Abth. II, p. 492.

1869, *Puccinia Peckiana,* Howe. 23 Rep. Bot., N. Y. State Museum, p. 57. Printed in 1872.

1870, *Puccinia tripustulata,* Peck. 24 Rep. Bot., N. Y. State Museum, p. 91. Printed in 1872.

1893, *Puccinia interstitiale* (Schlechd.), Tranzschel. Hedwigia, Heft. 5, p. 257.

So far as can be made out from the above and other references, the the history of the fungus is as follows:

In 1817, Ehrenberg, while on a journey, made some collections of fungi in Kamtchatka. Schlechtendal, in 1820, while working over the Caeoma of this collection, came across one on *Rubus arcticus*, which he described as a new species under the title of *Caeoma interstitiale.* Two years later, Schweinitz, of America, in publishing the fungi collected in Carolina, also described as new a fungus on *Rubus strigosus*, to which he gave the name, *Aecidium nitens.* In 1825, Link, writing up descriptions of known fungi, gave both Schlechtendal's fungus and Schweinitz' fungus, in the latter case, however, placing the fungus in the genus Caeoma and retaining Aecidium as a subgenus. Then, without authority as recognized to-day, he rejected the specific term applied by Schweinitz and substituted "luminatum" for the same. When Sprengel published the *Systema Vegetabilium,* in 1827, he recognized the Asiatic and American forms as the same, for he gave ***Aecidium nitens*** Schw. as a synonym for *Uredo interstitialis*, Schl. Schweinitz, in his second publication, in 1831, accepted the specific name as exchanged by Link, but added his own name as the authority. According to Tranzschel the fungus was again described as new in 1859 by Dietrich, who used the name *Uredo lucida.* Streinz (1862), in his *Nomenclator fungorum*, placed the forms of Schweinitz and Schlechtendal together, recognizing "interstitialis" as the specific term; and Oudemans (1891), in a note in *Hedwigia*, again called attention to their identity. Some considerable confusion has been caused by Karsten (1879), who described this Caeoma as the Aecidium form of *Phragmidium Rubi.* Winter (1884), used this description of Karsten's, but stated that he had never seen this stage of Phragmidium, but in 1885 he evidently recognized the Caeoma as distinct. Krieger, however, by finding and describing the real aecidium form of *Phragmidium Rubi* has cleared up this difficulty. It seems from the references to be found that Trelease first called the fungus *Caeoma nitens*, and that Curtis is responsible for *Uredo nitens* and *Uredo luminata.* The above terminalogy not being sufficient for the botanists of to-day, various combinations have been made and Schweinitz has been burdened as the authority in most cases. Such are *Uredo luminata, Caeoma* (*Uredo*) *luminatum, Uredo* (*Caeoma*) *nitens, Uredo caeoma-nitens, Caeoma nitens, Caeoma luminatum, Uredo luminatum, Uredo nitens, Aecidium luminatum.*

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* References marked thus (*) I have not been able to examine personally.

The history of the mature stage is briefer, perhaps on account of its late discovery. In 1869 Howe described a new Puccinia found on the raspberry as *P. Peckiana;* while the next year, Peck, finding it on the blackberry, and thinking it different, described it as *P. tripustulata.* Burrill, in 1885, called attention to these as identical, adding that they were now so considered by Peck. Lately, Tranzschel, by culture experiments connecting the Caeoma and the Puccinia, has taken the first specific name given to the Aecidium form and called the fungus *Puccinia interstitiale* (Schlechd). We believe, however, with Farlow,* and and it seems to be the usual method, that when such forms are found to be connected the specific name of the mature stage should be retained, in which case *Puccinia Peckiana*, Howe, is still proper and should be retained.

DISTRIBUTION.

From notes printed in various publications, the following distribution of the fungus has been obtained.

The aecidium stage has been reported as follows in the United States—Carolina, Schweinitz; Connecticut, Thaxter; Georgia, Ravenel; Illinois, Burrill; Iowa, Arthur; Kansas, Kellerman; Maryland, Brunk; Massachusetts, Sprague; Minnesota, Sheldon; Mississippi, Earle; Missouri, Demetrio; Nebraska, Webber; New Hampshire, Seymour; New Jersey, Britton; New York, Peck; Ohio, Detmers; Pennsylvania, Schweinitz; Texas, Jennings; West Virginia, Millspaugh; Wisconsin, Trelease. In Canada—Ottawa, Ellis & Everhart. In Europe—Bavaria,

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*Proceedings American Academy of Arts and Sciences, 1883, p. 66.

Allescher; Finland, Kihlman; France, Cornu; Scandinavia, Eriksson; Russia, Tranzschel. In Asia—Siberia, Thümen; Kamtchatka, Schlechtendal. In European and Asiatic Russia, Tranzschel also gives the following: Gouv. St. Petersburg, Gouv. Archangelsk, Gouv. Moscow, Gouv. Esthland, N. Ural, and Minussinsk, and region of Semipalatinska, and Enisseisk.

The stations of the teleutostage are more limited and as follows: In the United States—Illinois, Burrill; New York, Howe; Massachusetts, Farlow; Missouri, Galloway. In Europe—Lapland, Lagerheim; Russia, Tranzschel.

HOSTS.

The hosts of the aecidum stage are as follows: In the United States—*Rubus Canadensis*, *R. hispidus*, *R. occidentalis*, *R. strigosus*, *R. triflorus*, *R. trivialis*, *R. villosus*. In Europe and Asia—*R. saxatilis*, *R. arcticus*.

For the teleutostage hosts have been reported as follows: United States—*Rubus occidentalis*, *R. strigosus*, *R. villossus*. Europe—*R. arcticus*, *R. saxatilis*.

INDIVIDUAL HOSTS.

The following table proves an intimate relationship existing between this Caeoma and the Puccinia, as shown by their occupancy of the same individual plants.

INDIVIDUAL HOSTS OF CAEOMA AND PUCCINIA.

Spermagonia, May 17th.	Caeoma, June 9th.	Puccinia, July 6th–14th.
1. Raspberry. Leaves of old and new shoots affected.	Affected.	Old with few lower leaves still present and badly affected.
2. Rasp. Old and new affected.	Old affected.	Old nearly all dead, like lower, new badly affect'd.
3. Rasp. Old affected, new shoots not yet developed.	Old affected	Dead, but some dead leaves slightly affected.
4. Rasp. Old and quite young new affected.	Old affected.	Dead, and leaves all dried up.
5. Rasp. Old free. The single new affected.	Old free. New affected.	Failed to find plant.
6. Rasp. No old. The single new partly affect'd	One new affected.	One lower leaf affected, near Caeoma affected leaf.
7. Rasp. Three old free. Two new affected	Two old free. Two new affected.	One old, lower leaves badly affected; single new affected live leaf.
8. Rasp. Old free. New affected.	Old free. Four new affected.	Old, nearly dead, slightly affected.
9. Rasp. One old free. Three new affected.	One old free. Three new affected.	Several new, nearly dead, free. One old affected.
10. Rasp. Three old free. Many small new mostly affected.	Three old, three new, free. Four new affected.	Old and new affected, some badly.

INDIVIDUAL HOSTS OF CAEOMA AND PUCCINIA—*Continued.*

Spermagonia, May 17th.	Caeoma, June 9th.	Puccinia, July 6th–14th.
11. Rasp. One old free. Five new affected.	One old free. Three new affected.	Several new, without lower leaves, free. One old, one new, affected.
12. Rasp. One old free. Bunch of new affected.	Two old, one new, free. Two new affected.	Old and new affected.
13. Rasp. One old free. One new affected.	One old free. One new affected.	Two new, with few lower leaves, free. One old affected.
14. Rasp. One old, one new affected.	One old affected.	Dead, but plant near badly affected.
15. Rasp. One new affected.	Failed to find plant.	Three new, lower leaves affected.
16. Rasp. Two old, some new, slightly affected.	Two old, two new, affected.	Two old, nearly dead, slightly affected; new, lower leaves slightly affected.
17. Rasp. One new affected.	One new affected.	One new, lower leaves mostly dead; but with one affected.
18. Rasp. One old free. Several new affected.	One old free. Two new affected,	Failed to find plant.
19. Rasp. Several old free. Several small new slightly affected.	One old, five new, free. Two new slightly affected.	A few lower leaves affected.
20. Rasp. One weak old free. Bunch of new affected.	Practically dead.	Practically dead, but with single live leaf affected.
21. Rasp. Bunch of new affected.	One new affected.	Slightly affected.
22. Rasp. One old, several new, affected.	One old free. One old, three new, affected.	Affected.
23. Rasp. Two old, one new, affected.	One new free. One old, one new, affected.	One new, with lower leaves affected.
24. Rasp. One old, nearly dead; several new, affected.	One old, five new, affected.	Practically dead, with two or three affected leaves.
25. Rasp. Several old affected. No new of importance.	Failed to find plant.	Dead.
26. Rasp. Two old free. Three new affected.	One old free. Three new affected.	One old, two new, affected.
27. Rasp. One old nearly dead, some new, affected.	Abundantly affected.	Practically dead, free.
28. Blackberry. Old nearly dead, some new, affected.	Abundantly affected.	Lower leaves affected.
29. Blackberry. One old nearly dead, some new, affected.	Abundantly affected.	Practically dead, some lower leaves affected.

INDIVIDUAL HOSTS OF CAEOMA AND PUCCINIA—*Continued.*

Spermagonia, May 17th.	Caeoma, June 9th.	Puccinia, July 6th–14th.
30. Rasp. Old nearly dead, some new, affect'd.	Affected.	Old without leaves; new without lower leaves; upper free.
31. Rasp. One old free. One new affected.	Abundantly affected.	A few lower leaves slightly affected.
32. Rasp. Two old free. One old, some new, affected.	Abundantly affected.	Failed to find plant.
33. Rasp. Two old, some new, affected.	Abundantly affected.	Old without leaves; new free.
34. Rasp. Old free. New, affected.	Abundantly affected.	Old affected; new, without lower leaves, free.

A number of the above plants were affected by the spermagonia and the aecidium stage on the new shoots only. This does not necessarily mean that those plants were affected for the first time, for the fungus may have had such a disastrous effect on those shoots infected the previous year as to have killed all of them, a thing quite apt to occur. It will also be seen that a number of plants were killed entirely. Of the living plants there were only three found in June that were not affected with the Puccinia, and these had their leaves so destroyed by the aecidium stage as to render subsequent infection unlikely.

The following serves as a sort of check to the above. These plants were examined at the same time as the above for the Puccinia. They were in the same locality, and at varying distances from plants affected by the aecidium stage; but, as none had been affected by this stage, their chance of being host to the Puccinia depended considerably on their distance from plants having the Caeoma. There were thirteen plants free and seven on which the Puccinia was found. All the affected ones were near plants that had the aecidium form.

a. Raspberry. A healthy plant. Two old, two new shoots, free. Several rods from plants affected with aecidium stage.
b. Rasp. Rather vigorous. One old, two new, free. Near a.
c. Rasp. Vigorous. Single new, apparently free. Near a.
d. Rasp. Sickly. One dead old, one new, free. Near a.
e. Rasp. Healthy, One old, two new, free. Two or three rods from affected plants.
f. Rasp. Rather sickly. Free. Near e.
g. Rasp. Rather sickly. One dead old, one new, free. Near e.
h. Rasp. One new free. One old with single leaf slightly affected. Three feet from affected plant 27.
i. Blackberry. Healthy. One old, one new, free. Five feet from affected plant 27.
j. Rasp. Vigorous. One old, one new, free. Three feet from affected plant 27.
k. Rasp. Two new free. One old, one new, rather abundantly affected. Two feet from affected plants 22, 23, 24, 25.
l. Rasp. One new free. One old affected. Near k.
m. Rasp. One old, one new, free. One old slightly affected. Near k.
n. Rasp. One old, several new, affected abundantly on lower leaves. Near k.
o. Rasp. One old, two new, rather abundantly affected. Near k.
p. Rasp. Several old and new free. Ten feet from two affected plants.

q. Rasp. Two old, two new, free. Near p.
r. Rasp. One old, one new, free. Near p.
s. Rasp. One old, one new, free. Close to an affected plant.
t. Rasp. Old and new affected. Close to affected plant.

EXSICCATI.

In exsiccati the Caeoma and Puccinia here considered, on the dates given, were distributed under different names as follows:

1852, *Aecidium luminatum*, Schw., Ravenel's Fungi Caroliniani, V. 1, n. 91.
1876, *Uredo luminatum*, Curtis, on *Rubus Canadensis*, De Thümen's Mycotheca Universalis, C. V., n. 446.
1879, *Uredo luminatum*, (Schw.), on Rubus, Ravenel's Fungi Americani, C. III, n. 276.
1879, *Caeoma luminatum*, (Schw.), on *Rubus Strigosus*, Ellis' N. A. F., C. III, n. 277.
1885, *Caeoma nitens*, (S.), on *Rubus villosus*, *R. saxatilis*, Rabenhorst's Fungi Europaei, C. XXXIII, n. 3225, a. b. c.
*1887, *Caeoma nitens*, (Schw.), Eriksson's Fungi parasitici scandinavici, exsiccati, F. IV.
*1889, *Caeoma nitens*, Schw., on *Rubus villosus*, Kell. & Swingle's Kans. Fungi, F. II, n. 31.
*1890, *Caeoma nitens*, Schwein, on *Rubus saxatilis*, Allescher & Schnabl's Fungi Bavarici exsiccati, C. I.
1890, *Caeoma nitens*, (S.), on *Rubus Canadensis*, *R. villosus*, Seymour & Earle's Eco. Fungi, F. I., n. 27, 28.
1879, *Puccinia Peckiana*, Howe, on *Rubus occidentalis*, Ellis' N. A. F., C. III, n. 261.
1890, *Puccinia Peckiana*, Howe, on *Rubus villosus*, Seymour & Earle's Eco. Fungi, F. I., n. 26.

LITERATURE.

The following references are such as have been used in the preparation of this paper. Scattered through agricultural and horticultural papers are notes on the "Orange Rust," which we have not cited, save in one or two instances. While it has been the intention to include all articles or notes of scientific importance on this subject, it is quite probable that some may have escaped observation.

Allescher, 1888, Bot. Centralblatt, B. XXXVI, p. 287, notes finding Caeoma nitens on Rubus saxatilis near Allach in 1878, and mistaking it for a form of Phragmidium Rubi.

Arthur, 1884, Bull. Iowa Agr. Coll., p. 164, lists C. nitens as occurring on blackberry in that state.

Bessey, 1885, Rep. Amer. Pom. Soc., p. 43, lists C. luminatum among the injurious fungi of horticulturists.

Botanisches Centralblatt, 1887, B. XXIX, p. 158, gives C. nitens as one of the fungi in the IV Fas. Fungi parasitici scandinavici, which appeared about this date.

Brendel, 1887, Flora Peoriana, p. 69, lists C. nitens from Peoria Co., Ill.

Britton, 1889, Geol. Surv. New Jersey, V. II, P. I. p. 503, gives Uredo luminata on R. strigosus from New Jersey.

Brunk, 1890, Ann. Rep. Md. Agr. Coll. and Ex. Sta., p. 115, mentions twenty varieties of blackberries affected by C. nitens, and gives notes on degree of affection. 1891 Rep. same publication, pp. 389 & 416, gives results of spraying and notes on varieties affected.

Burrill, 1882, Agr. Review, p. 88, gives an account of Caeoma luminatum.
1885, Parasitic Fungi of Illinois, P. I, pp. 178, 220, gives scientific descriptions of C. nitens and P. Peckiana, and suggests relationship.
1885, Rep. Ill. Industrial Univ., p. 115, writes scientific description of P.

Peckiana, also p. 138 same, of C. nitens, and suggests a connection between them.

1885, Prairie Farmer, V. LVII. p. 762, gives detailed structure of C. nitens, etc.

1885, Reprint from Amer. Soc. Micr., pp. 3, 8, gives general description and possible connections of C. nitens.

*Cobb, 1887, List Pl. Amherst, p. 39, gives Uredo luminata.

Cooke, 1878, Grevillea, V. VII, p. 46, lists Uredo luminatum from Georgia.

Cornu, 1881, Bull. Soc. Bot. France, p. 145, gives an account of finding Ae. luminatum on Rubus in France, mentioning it as new to Europe.

Cragin, 1885, Bull. Washburn Coll., V. I, n. 2, p. 68, lists C. luminatum from Kansas.

*Curtis, 1867, Bot. N. Car., p. 122, gives Uredo luminata.

Day, 1883, Cat. Plants of Buffalo and vicinity, gives Uredo luminata in the list.

Detmers, 1891, Ohio Ex. Sta., Bull. No. 6, p. 127, makes a general description of C. nitens with its effect on host.

1892, Same Pub., V. V, No. 7, p. 137, mentions finding what seems to be an uredo stage of C. nitens, etc.

1893, Same Pub., Tech. Series, V. I, No. 3, p. 180, describes further this supposed uredo form of Uredo (Caeoma) nitens, etc.

De Toni, 1888, Saccardo's Sylloge Fungorum, V. VII., P. II, p. 866, gives synonyms, hosts, and description of Uredo (Caeoma) nitens, also p. 699 treats P. Peckiana similarly.

Dietel, 1887, Botanisches Centralblatt, B. XXXII, p. 87, makes mere reference of variability of spores of P. Peckiana, as shown by Lagerheim, 1887.

1892, Bot. Centralblatt, B, XLIX, p. 270, gives reference to two articles on Russian Uredineae by Gobi and Tranzschel.

*Dietrich, 1859, Blicke in die Cryptogamenwelt der Ostseeprovinzen, abth. II, p. 492, describes, according to Tranzschel, this Caeoma as a new species, Uredo lucida.

Earle, 1889, U. S. Dept. Agr., Sec. Veg. Pathol., Bull. No. XI., pp. 84, 85, 88, gives results of spraying with Bordeaux mixture blackberries affected with C. nitens.

*Ellis, 1889, Cat. Pl. New Jersey, 503, gives Uredo luminata.

Ellis & Everhart, 1885, Journal of Mycology, V. I, p. 86, give C. luminatum on R. triflorus from Ottawa, Canada.

Ex. Sta. Record, Vol. II, pp. 32, 455, 482; V. III, pp. 161, 313, 411, 722, makes reference to different Ex. Sta. notes on C. nitens.

Evans, 1893, Handbook Ex. Sta. Work, U. S. Dept. Agr., p. 283, gives account of general appearance of C. nitens.

Farlow, 1876, Bull. Bussey Institution, p. 432, lists P. Peckiana as occurring in Massachusetts.

1883, Proc. Amer. Academy Arts and Sciences, p. 76, gives a general description of appearance of Ae. nitens, and suggests that this may prove to be a heteroecious fungus.

Farlow & Seymour, 1888, Host Index U. S. Fungi, p. 37, give hosts and synonyms of C. nitens and P. Peckiana.

*Frost, 1875, Cat. Pl. Amherst, p. 84, lists Uredo luminata.

Galloway, 1889, U. S. Dept. Agr., Bot. Div., Bull. VIII, pp. 56, 58, lists C. nitens and P. Peckiana from Missouri.

1889, Rep. U. S. Dept. Agr., p. 416, speaks of spraying experiments made by Earle. Printed in 1890.

Gardner's Monthly, 1871, pp. 211, 266, correspondents give notes on "orange rust" of blackberry, treatment, etc.

Hoffman, 1863, Index Fungorum, p. 3, lists Ae. luminatum with "nitens" as the synonym.

Howe, 1869, (23) Rep. Bot. N. Y. State Museum, p. 57, gives description of a new fungus, Puccinia Peckiana, on Rubus occidentalis. Printed in 1872.

Humphrey, 1890, Ann. Rep. Mass. Ex. Sta., p. 224, mentions C. nitens as common there, etc. Printed in 1891.

Jennings, 1890, Texas Ex. Sta., Bull. No. IX, p. 23, mentions C. nitens as quite a drawback to culture of blackberry, and mentions it as also found on wild plants of R. trivialis.

Journal of Mycology, 1889, p. 103, gives reference to Lagerheim's 1889 article and p. 161, lists C. nitens as in Kellermann & Swingle's Kans. Fungi, Fas. II.

Kellerman, 1885, Washburn Coll. Bull., V. I, n. 2, p. 74, gives host of C. nitens in Kansas.

Karsten, 1879, Mycologia Fennica, P. IV, p. 51, describes what is probably C. nitens as aecidium form of Phragmidium bulbosum (Ph. Rubi).

Lagerheim, 1887, Botanisker Notiser, p. 60, gives an account of finding P. Peckiana on R. arcticus in Lapland, discusses forms of this fungus as found in different localities, and suggests C. nitens as a stage of Ph. Rubi rather than of P. Peckiana.

1889, Hedwigia, B. XXVIII, H. 2, p. 110, treats of distribution, of hosts, and of the relationship of C. nitens to other forms, and, as Krieger has found the aecidium stage of Ph. Rubi, now thinks the Caeoma heteroecious.

1890, Hedwigia, p. 173, gives mere reference to variability of position of germ pore of P. Peckiana.

Link, 1825, Species Plantorum, T. VI, P. II, p. 61, n. 166, describes C. luminatum and gives its host and locality as taken from Schweinitz, but instead of adopting the latter's name for the fungus gives it one on his own account.

Same, p. 32, n. 89, gives description, hosts, locality and name of Schlechtendal's (1820) Caeoma interstitiale,

Ludwig, 1884, Bot. Cent., B. XX, p. 356, reviews Trelease's 1884 article.

1887, Botanisches Centralblatt, B. XXXI, p. 162, makes a short abstract of Lagerheim's 1887 article.

Magnus, 1890, Separat-Abdruck aus Hedwigia, H. 6, gives C. nitens as one of the interesting fungi in Cent. I, Fungi Bavarici.

Millspaugh, 1892, West Va. Agr. Ex. Sta. Bull., n. 24, p, 509, gives C. nitens as found in that state on R. hispidus.

Newcombe, 1891, Jour. Mycology, Vol. IV. p. 106, proves mycelium of C. nitens to be perennial in its host. Remarks by Galloway on consequent treatment.

New York Agr. Ex. Sta., Bull. n. 36, p. 641, mentions orange rust as a troublesome disease of raspberry.

Oudemans, 1891, Hedwigia, H. 3, p. 178, refers to Caeoma interstitiale published by Schlechtendal in 1820, it being collected by Ehrenberg in 1817 in Kamtchatka on Rubus arcticus, states that the illustration given of this fungus corresponds exactly with that of C. nitens, which must now be known as C. interstitiale, as this one was published two years earlier.

Peck, 1868, (22nd) Rep. Bot. N. Y. State Museum, p. 92, lists Uredo luminata as common on Rubus. Printed in 1869.

1870, (24th) Rep. p. 91, gives scientific description of Puccinia tripustulata, n. s. found on Rubus villosus. Printed in 1872.

1871, (25th) Rep. pp. 113, 114, gives scientific descriptions of P. tripustulata, Pk. and P. Peckiana, Howe, which at that time he considered distinct. Printed in 1873.

1873, (27th) Rep. p. 77, notes Uredo luminata as rapidly becoming a serious drawback to the culture of blackberries and raspberries. Printed in 1875.

1875, (29th) Rep. p. 72, lists P. Peckiana and P. tripustulata, also p. 75, lists Uredo luminata as found there on R. villosus, R. Canadensis, R. occidentalis, R. strigosus. Printed in 1878.

Richards, 1893, Proc. Amer. Acad. Arts and Sciences, p. 31, treats of development of the spermagonia of C. nitens, and states that they do not originate in one greatly enlarged epidermal cell.

*Schlechtendal, 1820, Horae physicae Berolinenses, p. 96, t. 20, f. 13., describes and figures C. interstitiale as new, it being collected by Ehrenberg in Kamtchatka in 1817 on R. arcticus.

Schroeter, Ein Beitrag zur Kenntniss der nordischen Pilze. p. 7, gives C. nitens as found in Sweden.

Schweinitz, 1822, Synop. Fungi Carolina, p. 69, n. 458, describes Ae. nitens, n. s. on Rubus strigosus.

1831, North Amer. Fungi, p. 293, n. 2887, gives his former Ae. nitens as Caeoma (Aecidium) luminatum, Schw., his specimen this time being from Pennsylvania. Printed, 1834.

Scribner, 1886, Rep. U. S. Dept. Agr., p. 133, lists C. nitens from Michigan. Printed 1887.

Seymour, 1886, Reprint from Minn. Hort. Rep., V. XIV, gives some facts concerning life history of C. nitens.

1887 Amer. Naturalist, p. 1115, notes a more erect and rigid growth of plants attacked by C. nitens.

Sprague, 1856, Proc. Boston Nat. Hist. Soc., p. 328, lists Uredo nitens as occurring in Massachusetts.

Sprengel, 1827, L. Sys. Veg. 16 ed., V. IV, p. 574, gives scientific description of Uredo interstitialis, Schl., which he considers the same as Aecidium nitens, Schw.

Streinz, 1862, Nomenclator fungorum, p. 644, n. 10757, gives Uredo interstitialis, Spr., with Ae. nitens, Schw., C. interstitiale, Lk., and C. luminatum, Lk. as synonyms.

Thaxter, 1889, Ann. Rep. Conn. Ex. Sta., p. 172, gives C. nitens as common on cultivated and wild raspberries and blackberries, and suggests method of treatment. Printed in 1890.

*Thümen, 1880, Beitrage zur Pilz-Flora Sibiriens, III, p. 14 gives Uredo luminata as found in Asiatic Siberia.

Tranzschel, 1892, St. Petersburg Naturforscher Gesellschaft (Bot. Section), gives preliminary report on producing P. Peckiana by means of artificial infection of R. saxatilis with spores of C. interstitiale (C. nitens).

1893, Hedwigia, H. V., p. 257, gives further successful results of artificial infection, and concludes that the Caeoma and the Puccinia must hereafter be known as stages of Puccinia interstitiale (Schl.)

Trelease, 1884, Extract from Trans. Wis. Academy of Science, Arts and Letters, V. VI, p. 30 gives host of C. nitens in Wisconsin. Probably the first to call this fungus Caeoma nitens.

1884. Psyche, V. IV, p. 195, notes insect larvae as eating spores of C. nitens.

Underwood & Cook, 1889, Illustr. Fungi, 51, give C. nitens.

Watt, 1885, Canadian Naturalist and Geologist, Second Series, V. II, p. 391, gives Ae. laminatum, the specific term probably being "luminatum" misspelled.

Webber, 1889, Extract from Rep. Neb. State Board of Agr., p. 73, notes Uredo (C.) nitens as being very destructive.

1889, Neb. Agr. Ex. Sta., Bull. No. 11, lists same on p. 65, and Pond mentions it on p. 89.

Winter, 1884, Rabenhorst's Kryptogamen Flora I-I, p. 230, gives Karsten's (1879) description of I stage of Ph. Rubi, although he states that he has never seen the same for certain.

1885, Hedwigia, B. XXIV, p. 181, gives C. nitens on R. villosus and R. Canadensis, as sent from Missouri by Demetrio.

1885, Rabenhorst's Fungi Europaei, C. XXXIII, n. 3225, presents specimens of C. nitens for America and Fennia, and says that Fennia specimens are C. nitens rather than a form of Ph. Rubi for which they were sent to him.

G. P. CLINTON, B.S., Assistant Botanist.

EXPLANATION OF PLATES.

Plate 1. Fig. 1. Under surface of blackberry leaf thickly covered with sori of aecidium stage.

Fig. 2. Under surface of raspberry leaflet, with both aecidio- and teleuto-sori.

Fig. 3. Under surface of blackberry leaflet, with teleutosori in groups.

Fig. 4. Upper surface of raspberry leaflet, with peculiar mottled appearance frequently caused by teleutostage of fungus.

Fig. 5. Cross section of blackberry leaflet through a sorus of the aecidium stage.

Plate 2. Fig 1. Cross section showing part of blackberry leaflet with a spermagonium beginning to form just beneath the epidermis.

Fig. 2. Slightly more advanced stage.

Fig. 3. Mature spermagonium in cross section.

Plate 3. Fig. 1–4. Haustoria in pith of very young shoot of blackberry, as seen in cross section. 2 and 3 show the peculiar conjugation sometimes found.

Fig. 5–7. Haustoria in pith of old blackberry stems, in cross section, 5 and 6 being more highly magnified than 7.

Fig. 8–9. Mycelium in longitudinal sections of blackberry pith, 8 being from a young and 9 from an old cane.

Fig 10. Section with mycelium and a haustorium in parenchyma tissue of very young leaf.

Fig. 11–13 Cross section of parenchyma cells in cortex of root, with mycelium of fungus, 11 showing cross end of mycleium between the cells, 12 and 13 haustoria.

Fig. 14. Tangential section with mycelium and a haustorium in parenchyma cells of root cortex.

Plate 4. Fig. 1–21. Aecidiospores germinating in water.

Fig. 1-7. Germination of same spore at end of 4, 5, 6, 7, 8, 9, and 24 hours.

Fig. 8-12. Germination of spores during first two days, and 13 during third day.

Fig. 14-18. Spores from raspberry, having been 48 hours in water, while 19-20 show quicker germination at end of 24 hours.

Fig. 21. Peculiar tips of germ tubes, two showing suddenly enlarged tips, and three flexuous tips.

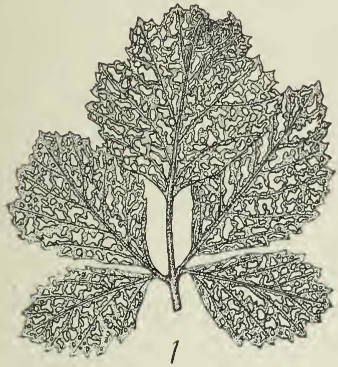
Fig. 22. Aecidiospores that were placed on lower moist surface of blackberry leaf, showing contracted tip of germ tube, and method of entrance through stomates.

Fig. 23. Peculiar branch of germ tube of a spore sown on blackberry leaf.

Fig. 24-29. Teleutospores germinated in water, at end of eight days. 24, 26, 28, 29, optical sections of the spores, showing how germ tube penetrates the exospore.

Fig. 30. Mycelium as seen beneath epidermis, and between guard cells of stomates. From blackberry leaflet just beginning to show teleutoform.

PLATE I



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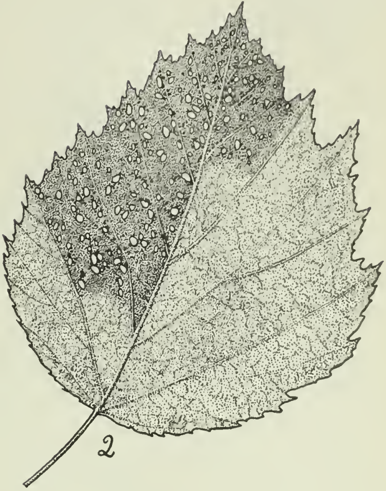

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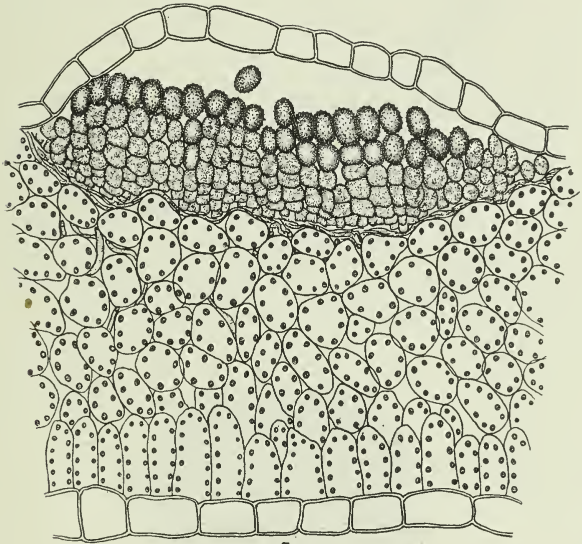

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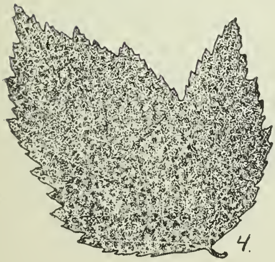

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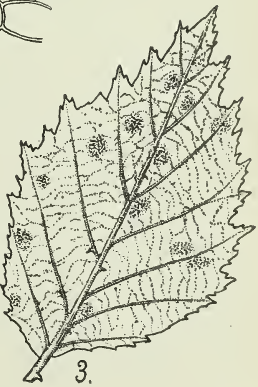

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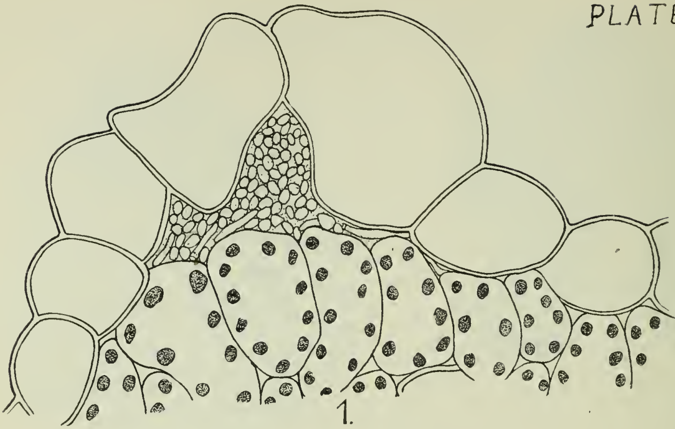

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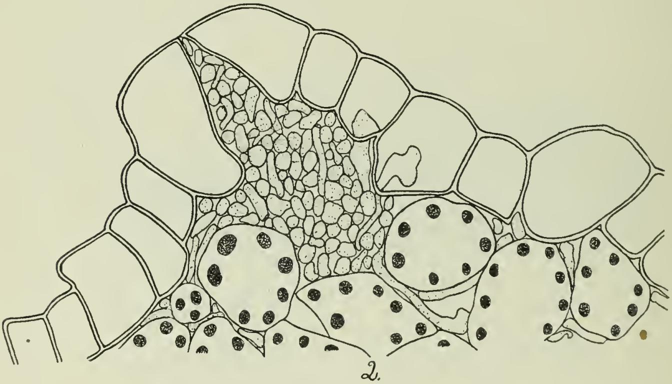

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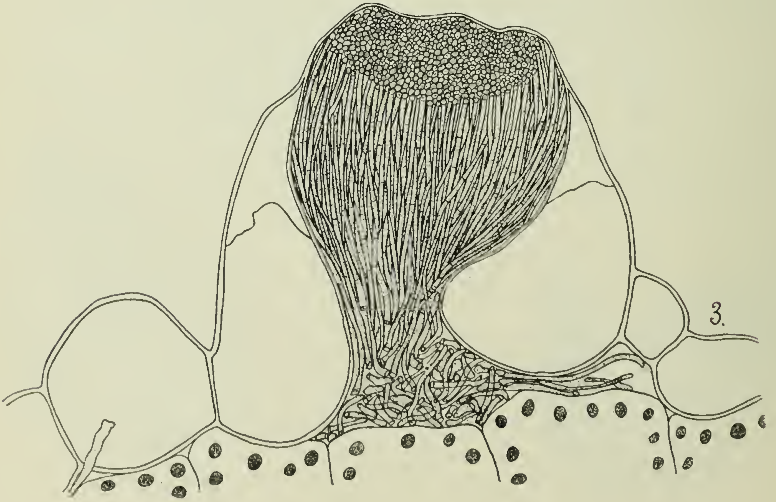

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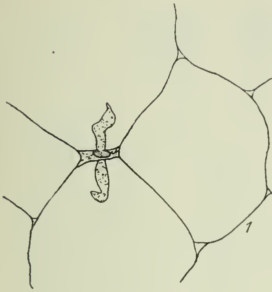
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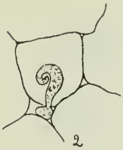
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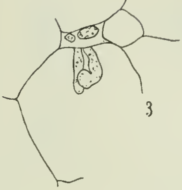
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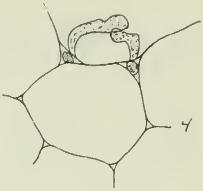
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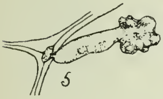
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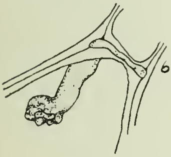
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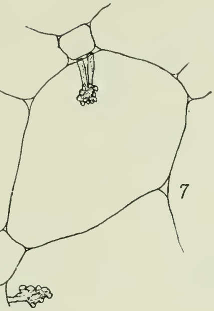
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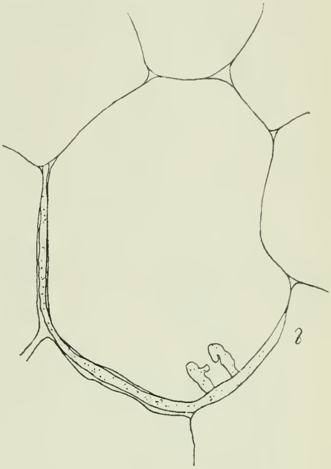
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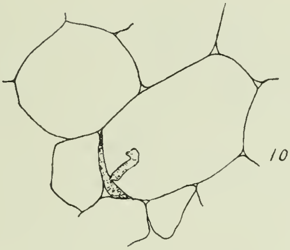
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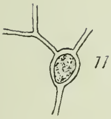
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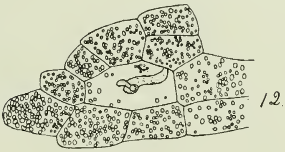
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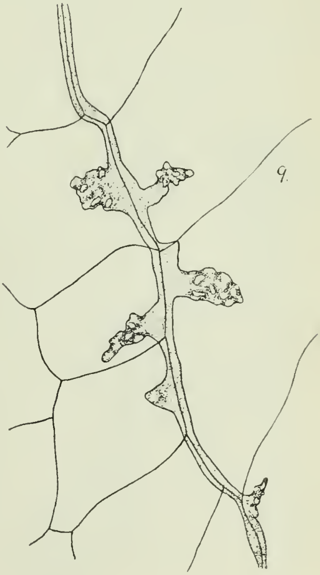
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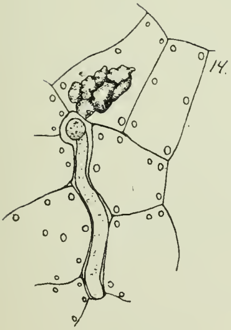
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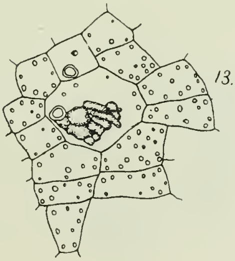
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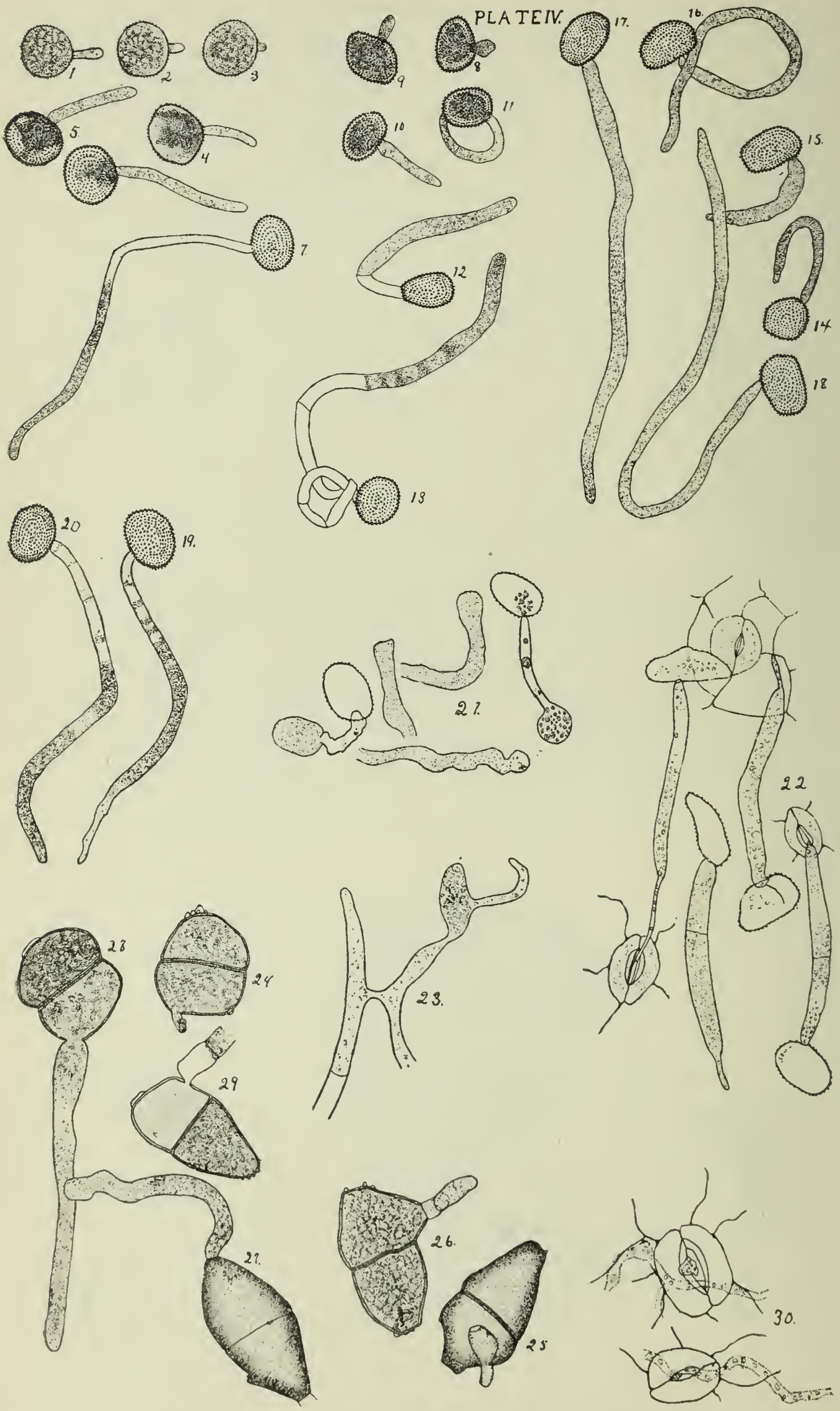
PLATE IV.



*A NEW FACTOR IN ECONOMIC AGRICULTURE.

Economic agriculture has in store many problems whose solution will greatly lessen labor while at the same time increasing the productiveness of the soil. There is no subject of greater interest and importance to physiological botany and agriculture than the recently discovered symbiotic relation between different organisms; a relation mutually beneficial and in many cases absolutely necessary to existence. It is the purpose of this paper to discuss a form of symbiosis which may prove to be of special interest to agriculture. Taking it for granted that most readers of these bulletins are practically unacquainted with the subject "Symbiosis," a condensed historical review of it from its beginning will be first given.

[*It has been well known for many years that clover, especially when plowed under, made a very marked contribution to the fertility of the soil upon which it grew, and later scientific investigations have shown that this plant, and some other allied ones, have the peculiarity of making use of the free nitrogen of the air as an element in their nutrition. Most other plants cannot do this, though all must have nitrogen as a food ingredient. It is usually taken from the soil in combination with other elements; as, for instance, in the lime forming nitrate of lime. Now four-fifths of the atmosphere is free nitrogen. If by any means plants can make use of it as food, they have an abundant and constant supply at hand and the combined form in the soil then becomes less important, or unnecessary. Since the latter is the most expensive of artificial fertilizers and its application is often demanded for full crops, any substitute for it must be of immense practical value.

It has now been shown that clover, like other agricultural plants, is of itself incapable of utilizing free nitrogen, but that it does so through the agency of low organisms (bacteria) found in little knots or tubercles which form like galls upon the roots. Such tubercles are found on the roots of all plants which are known to gain nutrition from free nitrogen and are not so found upon any other plants. They are not found upon the roots of any of the grasses or cereals. Can the organisms be made to grow upon these roots by any artificial means?

It must be confessed that it would have been exceedingly hazardous for any one to have expressed an affirmative opinion upon this question; but the vast importance of the matter made it desirable to try anything which gave the least promise of success. In this condition of things it came to the knowledge of officers of this Experiment Station that Dr. Albert Schneider, then of Minneapolis, Minn., had found from some preliminary investigations indications of the possibility of adapting the organisms by artificial cultivation to growth upon the roots of maize or of other cereals. He was therefore secured to continue these investigations during the latter part of the summer of 1893, and was given all the facilities at the command of the Station. The following from his pen gives the results as far as obtained. While little direct evidence has been gained in favor of ultimate success, it is considered desirable to publish an account of the work so far done with the hope of being able at some future time to add greatly to the information now obtained. The report is necessarily technical in form and several terms are employed that may be new to many who read these pages; but the subject matter is also new to the public and other wording could scarcely make it easier to comprehend. The term *symbiosis* is applied to the association of two different kinds of living plants or animals in a mutually helpful relation.

THOMAS J. BURRILL, Horticulturist and Botanist.]

Brief Historical Review.

The term symbiosis was first used by de Bary in 1879 in an article entitled, *Die Erscheinung der Symbiose.* By it he meant that kind of commensalism or consortism between different organisms which proved mutually beneficial. In parasitism the benefit is always one-sided, one organism flourishing at the expense of the other. The most familiar form of symbiosis is to be found in the case of lichens. Here we find an ordinary hyphal fungus living in vital relation with a filamentous or single-celled alga. The chlorophyll bearing algae make it possible for the fungus to develop on rocks and tree trunks where it could not exist alone. In turn the alga absorbs nourishment from the fungus. It is only a few years since the algae of lichens were looked upon as spores and hence named gonidia. The dual nature of lichens has been demonstrated both by analysis and synthesis. The algal and fungal portions of a given lichen have been separated and each found to be capable of existing alone. It has been found that by placing a certain fungus and alga together they form a true lichen.

A form of symbiosis of much greater importance is to be found with certain forest trees. Often the greater portion of nourishment is supplied by fungi. These fungi stand in symbiotic relation with the small rootlets of the tree forming a structure part root and part fungus, called a Mycorhiza. According to the researches of Frank the significance of this root symbiosis is to be explained as follows: The tree as well as the fungus requires humus; but the humus, before it can be readily taken up as food by the trees, must first be assimilated by the fungus. Frank and his pupil Schlicht have found symbiotic fungi among Ericaceae, Epadridiae, Empetraceae, and Orchidaceae.

Among the Leguminosae we meet still another form of symbiosis. Here one of the symbionts is a bacterium (Rhizobium) and is always to be found within the tissue of the host forming swellings called tubercles. The history of Rhizobia tubercles is very interesting and has led to many controversies.

The tubercles on the roots of Leguminosae had been noted as early as 1852, though no one understood their meaning. Malpighi considered them as galls; de Condolle, as pathological growths. Clos looked upon them as lenticular growths, while Treviranus, considered them undeveloped buds. Eriksson gave a more complete description of the tubercles of *Faba vulgaris.* In 1866 Woronin noticed that the soft parenchymatous cells of the interior of the tubercles were entirely filled with small bodies. He pronounced these bacteria. Most botanists coincided with Woronin as to the bacterial nature of the tubercle contents. These bacteria were looked upon as true parasites. In 1879 Frank pointed out that it was not an ordinary form of parasitism. In 1887 Hellriegel concluded a series of experiments which led him to the conclusion that there was some close relation between the root tubercles of Leguminosae and free nitrogen assimilation. Beginning with 1885 and ending in 1891, a heated controversy was kept up concerning the contents of the infected cells of tubercles. Heretofore they had been looked upon as bacteria. Brunchorst and Tschirch conducted a series of experiments in Frank's institute which led them to believe that the bacteria, so-called, were not bacteria but were bacteroid bodies formed by the plants themselves; that is, the bacteria-like particles were albuminous reserve products which were finally absorbed by the plant and utilized in maturing the seed. Frank readily seconded these conclusions. Brunchorst named these bacteria-like albuminous substances *Bakteroiden.*

Eriksson had already noted in some tubercles peculiar hyphal structures penetrating the tubercle. He asserts that these hyphae end in the meristem of the tubercle and that the *Bakteroiden* bud off from them within the vegetable cell. In 1887 Marshall Ward made a special study of the mode of infection in *Vicia Faba.* His observations coincided quite closely with those of Eriksson. The above mentioned hyphal structures Ward looked upon as true hyphae of a fungus belonging to the Ustilagineae. The *Bakteroiden* he considered as the spores. According to Vuillemin the *Bakteroiden* are simply differentiations of the cell protoplasm and the hyphal structures are to be looked upon as the tubercle producing organism. He maintains that he succeeded in staining a cell membrane and hence called it a true hyphal fungus belonging to the Chytridiaceae, naming it *Cladochytrium leguminosarum.* Beyerinck looked upon these hyphal structures as mere *Schleimfäden*, produced by the plant cells themselves. He supposed them to be formed from the remnants of spindle threads left after nuclear division had taken place. Relying upon this assumption he also endeavored to explain the fact that the *Schleimfäden* pass directly through the cell wall. The *Bakteroiden* Beyerinck considered the infecting organisms, formed from the microsomatic bodies found in the meristem cells of the tubercles. The microsomatic bodies were looked upon as bacteria which normally live within the soil but which are enabled to enter the plant root in some unknown way. He also seconded Brunchorst's and Frank's conclusions that the *Bakteroiden* are re-absorbed by the plant. Prazmowski looked upon the hyphal structure as a plasmodium filled with bacilli-like organisms. As soon as these enter the root parenchyma the plasmodium surrounds the cell protoplasm so that cell protoplasm, plasmodium, and the bacilli-like bodies form a thorough mixture. Here the bacilli-like bodies are converted into the *Bakteroiden.* Later Prazmowski changes his opinion, maintaining that the plasmodium is a hyphae-like tube filled with bacteria. The spores of the bacteria enter the root hairs in some way and multiply enormously. The bacteria tube pushes forward as far as the meristem of the tubercle where it dissolves and liberates the bacteria; the latter become mixed with the cell protoplasm, and are finally converted into the peculiar *Bakteroiden.* Schroeter considered the hyphal structures as true plasmodia of a fungus belonging to the Myxomycetes. This fungus he named *Phytomyxa leguminosarum*. Frank came to the conclusion that the hyphal structures were products of the plant cells themselves, and served the purpose of assisting the Rhizobia into the root parenchyma, hence he named them *Infektionsfäden*.

According to Frank infection takes place as follows: The roots of Leguminosae secrete a substance which serves as an attraction to the Rhizobia in the soil. They accumulate and multiply on the surface of the root, some of them enter the outer cells and are then conducted into the interior by the *Infektionsfäden*. Here the Rhizobium assimilates the cell protoplasm and becomes much changed in form, finally becoming converted into *Bakteroiden*. In 1890 he believed with Brunchorst that the *Bakteroiden* were albuminoid bodies formed from the cell protoplasm, in which the Rhizobia were imbedded. In 1891 he changes his opinion in regard to *Bakteroiden* maintaining that they are true bacteria, as stated above.

So far Frank adheres to the opinion that there is but one species of Rhizobium, namely: *Rhizobium leguminosarum*. Investigations by the writer have led to the belief that there are at least several species. One and the same species may be found on different plants. For example, one species, designated *Rhizobium curvum*, was noticed on *Phaseolus paucifloris;* another, *Rhizobium mutabile*, was found on *Trifolium pratense* and *Trifolium repens*, on *Melilotus alba* and *Medicago sativa*. The much discussed *Infcktionsfäden* seem to bear an incidental relation only to the Rhizobia. It is not probable that the roots of Leguminosae secrete or excrete a substance that is attractive to Rhizobia. All later experiments, as far as known, verify these statements. Rhizobia in some way gain access to the surface cells of the roots and multiply and produce their peculiar changes in plant economy. Elsewhere the writer has described the root tubercle morphology and hence will not take up space here. It should be said, however, that the root tubercles are quite permanent in structure; and that it does not seem to the writer that the contents of Rhizobia and tubercles are at any time directly reabsorbed by the plant.

It would be impossible to review all the work that has been done in regard to the root tubercles and the free nitrogen assimilating Rhizobia they contain. Carefully considered and weighed, the discussions and controversies up to date may be summarized as follows:

1. Certain bacteria, called Rhizobia, live in symbiotic or mutually beneficial relations with certain higher plants, especially the Leguminosae.

2. Plants can develop without these Rhizobia, but, as a rule, thrive much better with them.

3. These Rhizobia have the power of assimilating for the use of the plant the free nitrogen of the air.

4. There are several species of Rhizobia.

5. *Rhizobium mutabile* very likely stands preëminent in the nitrogen assimilating function.

6. The *Infektionsfäden* probably have no essential relation to the Rhizobia.

7. The tubercles are abnormal growths produced by the presence of the Rhizobia.

8. The tubercles have a definite structure and form a permanent, coherent part of the root.

9. The *Bakteroiden* of Brunchorst (*Rhizobia mutabile*) are capable of being cultivated in suitable media.

Plan of Research.

The plan, though in a certain sense original, did not suggest itself spontaneously, but is the result of careful study.

That the Rhizobia play an important part in the vegetable kingdom is definitely settled. The results of Hellriegel's, Willfarth's, Lawes and Gilbert's, and Frank's experiments have opened a new era in economic agriculture. They have begun a work which will doubtless result in some great good.

Several interesting problems suggest themselves for solution. One, to which attention is here directed, is to ascertain if the Rhizobia of Leguminosae can be induced to live in symbiotic relation with plants of other families, as, for example, the Gramineae. If, for instance, the Rhizobium of the *Melilotus alba* root can be transplanted to the *Zea Mays* root and there continue its nitrogen-assimilating function, then our corn crop can be doubled and trebled with the same amount of labor now expended on an average crop. Of course it must be left for the future to decide whether this can be done. So far as known no experiments have as yet been attempted in this line. Knowledge of Rhizobia and bacteria in general leads to the belief that satisfactory results may be obtained. A brief outline of the plan of research which suggests itself is as follows:

1. To make a suitable culture medium.
2. To develop Rhizobia in this culture medium.
3. To change the culture medium by degrees from a leguminous nature to a gramineous nature.
4 To modify the Rhizobia by successively transferring from a highly leguminous medium to a highly gramineous medium.
5. To inoculate Gramineae with modified Rhizobia.
6. Life history of Rhizobia.

First, to make a suitable culture medium. Naturally, in order to induce the Rhizobia to develop outside of roots, there must be supplied artificially conditions approaching those of nature. Rhizobia, as they are found in root tubercles, are placed under the following conditions: 1. They are in a vegetable medium. 2. The medium is slightly acid in reaction. 3. They are not exposed to light. Artificially, these conditions can be supplied as follows: Instead of using the ordinary gelatine-peptone bouillon the purpose is to prepare a special culture medium from agar-agar and a water extract of certain leguminous roots, which is then made slightly acid in reaction and placed in the dark after being inoculated with a given species of Rhizobium. By this means all the above mentioned essential conditions are met with. Frank's (as well as those of others) failures to make cultures of the so called *Bakteroiden* were probably due to the fact that he did not supply the required conditions. Frank used gelatine-peptone bouillon. He neither mentions the reaction nor the light conditions. The writer attempted cultures in both gelatine-peptone and agar-agar bouillon, slightly alkaline in reaction and placed in the dark after being inoculated. *Bakteroiden* (*Rhizobium mutibile*) were not thus developed, but there was readily obtained a culture of *Rhizobiam Frankii*, var. *majus*. Recently Atkinson has succeeded in cultivating the *Bakteroiden* of vetch in an agar-agar peptone-vetch culture, which demonstrates conclusively that the *Bakteroiden* are true bacteria. The plan of the writer is to modify somewhat Atkinson's culture medium, and to omit the peptone which is an animal product. Instead of making an extract of the entire plant, roots only will be used. Atkinson does not state the reaction of his culture media, though it is to be supposed that they were acid, as vegetable cell sap is normally acid. Presumably he kept his cultures in diffused light, as he does not mention anything to the contrary. There would seem to be but little difficulty in preparing a suitable culture medium in which to develop Rhizobia.

The second step is, to develop Rhizobia in this special culture medium. The desire is to cultivate *Rhizobium mutabile* (*Bakteroiden* of Brunch.), as it is believed to be the one which has, preëminently, the power to assimilate free nitrogen. Since Atkinson has demonstrated that it can be cultivated, no doubts need be entertained on that score. All that is required is to place it in the proper medium under antiseptic precautions. Being once assured of a pure culture of *Rhizobium mutabile*, considerable progress is made toward the solution of the problem under consideration.

The third step, to change the culture medium by degrees from a leguminous nature to a gramineous nature, is of great importance. It is a well known fact that low organisms, especially bacteria, may become modified so as to adapt themselves to environments which proved fatal before they were thus modified. The purpose is to change the culture media so as to induce the Rhizobia to become modified. The plan is as follows: To make culture media in which the agar-agar is present in a constant percentage and the vegetable extracts variable. As already indicated the plan is to modify Rhizobia of a given leguminous plant so as to be capable of transplanting to the roots of a given gramineous plant. To begin with a culture medium will be taken which contains the fixed quantity of agar-agar and 100 per cent of extract of Melilotus roots; the culture medium next in the series shall contain 80 per cent Melilotus root extract and 20 per cent of *Zea Mays* root extract; the next in the series shall contain 60 per cent of Melilotus extract and 40 per cent of Zea extract and so on, each of the series differing by 20 per cent in the relative amounts of sweet clover and corn root extracts. At one end of the series is a culture containing 100 per cent of *Melilotus alba* root extract; at the other end, a culture containing 100 per cent *Zea Mays* root extract.

The fourth step explains itself from what has already been stated. The Rhizobia are to be transferred from one culture medium to another until they have passed through the series. By that time they are supposed to have become modified to such an extent as to grow and multiply in roots of corn.

This is to be attempted in the fifth step, to inoculate Gramineae with modified Rhizobia. The inoculation must be conducted with great care. Plants to be experimented upon should be placed in special glass jars. In place of soil, quartz sand will be used with culture solution. Plants must be grown in a medium which can be made perfectly sterile. The modified Rhizobia are to be transferred from the culture to the vessel containing the sterilized corn plants.

Lastly, the behavior of Rhizobia, will be carefully noted and their life history more carefully studied. Their behavior under normal and abnormal surroundings will be observed. Though present knowledge concerning the life history of Rhizobia warrants undertaking the experiments just outlined, yet it is quite essential that their life history should be more thoroughly studied, especially in regard to the following conditions:

1. *Temperature.*—(*a*) Minimum. (*b*) Optimum. (*c*) Maximum.
2. *Light.*—(*a*) Darkness. (*b*) Semi-darkness. (*c*) Green. (*d*) Blue. (*e*) Red. (*f*) Yellow. (*g*) White light (diffused). (*h*) White light (direct).
3. *Moisture.*—(*a*) Very dry. (*b*) Moderately moist. (*c*) Very moist.
4. *Atmospheric Pressure.*—(*a*) High pressure. (*b*) Low pressure.
5. *Heliotropism.*—
6. *Hydrotropism.*—
7. *Geotropism.*—

These experiments are not undertaken with any desire to magnify unduly the importance of bacteria, nor with absolute confidence of success. As already stated, the present knowledge of Rhizobia and bacteria in general justifies undertaking these experiments.

RESEARCH.

The first thing was to prepare suitable culture media in which to grow Rhizobia. For this purpose two aqueous extracts were made from *Melilotus alba*, one from the roots, rootlets, and tubercles; the other from the upper portions of stems and leaves. They were prepared in the following manner: About one-half a kilogram of roots and rootlets were weighed, carefully washed, then finely chopped, and put in a jar with one liter of distilled water. This was allowed to stand in a cool place for twenty-four hours, being shaken occasionally. The juice was then squeezed out through cloth into a beaker, and ten grams of agar were added. After standing for twelve hours the whole was heated to near the boiling point until the agar was dissolved. It was then filtered through coarse filter paper in a hot water filter. The agar extract medium of stems and leaves was prepared in a similar way. To portions of these filtered media were added peptonum, pancreatin, and salt in various proportions. Some neutral and slightly alkaline media were made by the addition of sodium carbonate solution. Litmus paper tests showed that the normal extracts of Melilotus roots and stems were acid in reaction, the latter more highly than the former. These various culture media were now ready for use.

Next, plants of *Melilotus alba* with normal, fully formed root tubercles were secured. The tubercles were removed, washed in distilled water, and quickly dried with blotting paper which had been passed through the flame of a Bunsen burner. The tubercle was then passed through the flame and cut with a sharp, sterilized knife, care being taken not to allow the knife blade to drag over the cut surface. Test tubes with culture media were then inoculated from the cut surface by means of a platinum needle. These inoculated test tubes, numbering about fifty, were set aside in a dark chamber at the normal summer temperature of the room. In about four or five days a whitish growth was noticed in most tubes containing agar extract of Melilotus roots. Examination under a medium power showed that they consisted of organisms resembling in size and form *Rhizobium Frankii*, var. *majus*. They were somewhat smaller, end spores less distinct, and the majority were motile during their early life history. They multiplied from spores as well as by transverse division. Their motility was especially noticeable in liquid media, often when of quite mature growth. Sometimes two or even more which had just completed division moved about with great rapidity. Their manner of movement led to the supposition that they possessed cilia. Staining heavily with Hoffman's violet and examining under a Zeiss' homogeneous immersion objective demonstrated the presence of cilia. Each motile organism generally possessed two cilia, one at either end, sometimes only one. Spores just beginning development sometimes had as many as three or four.

Tubes containing culture medium (acid) of stems and leaves of Melilotus showed no development of any kind for eight or ten days, when a small glistening colorless growth was noticed in several of them. Examination showed the presence of much modified *Rhizobium mutabile*. (Plate III, 5.) Cultures renewed from these tubes produced no further developments. In fact all growth ceased shortly in all tubes containing the extract of stems and leaves. The medium was no doubt too acid in reaction. Further efforts with various acid and alkaline media to secure pure cultures of *Rhizobium mutabile* were apparently unsuccessful. Careful examinations of tubercles and cultures obtained from them finally led to the following conclusions:

Tubercles of *Melilotus alba* contain two predominating types of Rhizobia, namely, *Rhizobium Mutabile* and the above described motile forms. These motile forms develop much more readily and by their great numbers prevent the subsequent development of *Rhizobium mutabile.* In the living plant cells the motile Rhizobia are found in the *Infektionsfäden* of Frank. They develop first and by their irritating presence cause the development of the *Fäden* which now are a means of separating the organisms from the other cell contents. This also explains the predominating presence of Rhizobia of *Fäden* in the meristem area of the tubercle. The motion of these Rhizobia is in the direction of their longer axis, hence the tubes (*Fäden*) are produced in the direction of the greatest expenditure of energy. As already stated the irritation caused by their motion induces the cell cytoplasm to deposit around them a coating of cellulose which gives the appearance of *Fäden*. These are found especially in the meristem area; but since the tubercles grow and the *Fäden* are as permanent a structure as the cell wall, they remain as tubes containing spores and mature Rhizobia. The Rhizobia are always found in a position parallel to the long axis of the *Fäden*, except where those peculiar bulgings and swellings occur. Staining the *Fäden* with chlorzinc-iodine showed the presence of a wall containing cellulose. Placing them in various culture media produced no growth or change of any kind; but the contained Rhizobia rapidly developed without producing any continuation of the *Fäden.* This demonstrated that the *Rhizobia* were not the cause of the development of the *Fäden* and that the *Fäden* are not living organisms. After the infected cells of the tubercle had become more mature, the second predominating type of Rhizobium, namely, *Rhiziobium mutabile*, began to develop and finally filled the entire cell. Some tubercles, especially the older ones contain, beside the predominating types, five or six other species. Since these seem to be the conditions of affairs, it can readily be understood how difficult it would be to obtain a pure culture.

It not being practicable to secure a pure culture of *Rhizobium mutabile* of *Melilotus alba*, the next attempt was to secure a pure culture of *Rhizobium Frankii*, var. *majus*, of *Phaseolus vulgaris* (garden bean), but here much the same difficulty was found. Bean tubercles contain also the above described motile form (*Rhizobium Frankii*) in small numbers. However, in order not to lose any more time, and supposing that any species of Rhizobium would serve much the same purpose for these preliminary experiments, bean Rhizobia cultures were continued. They readily grew upon bean-agar extracts and also upon mixtures of corn and bean extracts. It was supposed that they would also grow in pure corn-agar extracts. The question for solution was, How long will it be necessary to allow the Rhizobia to grow in corn-agar extract until they become sufficiently modified to develop in or upon corn roots? The purpose in passing the Rhizobia through a series of culture media made from corn-bean-agar extracts was to modify them gradually, else they might finally die out, if too long continued or suddenly transferred upon pure corn-agar extract. Though the Rhizobia developed upon pure corn root-agar extract, yet it was plainly seen that they grew much better in bean-agar extracts. After the Rhizobia were passed through the series of cultures they were placed in pure corn root-agar extract, a transfer being made every sixth day.

In one month from the time cultures were begun upon the pure corn extract, the first trial inoculations were made upon corn and oats plants which had been grown under the following conditions: Lemonade tumblers of heavy glass (large size) were obtained. A small hole was drilled through the bottom of each for drainage purposes. These were thoroughly washed and sterilized. In the bottom of each was placed a plug of cotton followed by one-half a gill of coarse gravel, then another plug of cotton followed by one-half a kilogram (about one pound) of carefully washed, tertiary quartz sand. The sand in the vessels was then moistened with distilled water. The vessels, with contents, were then placed in a hot air sterilizer for two hours at a temperature of 120° F. After the vessels were sufficiently cool they were planted with sterilized corn (white dent) and oats and placed on a table in the laboratory room. All the seed planted came up in about four days. Some plants were inoculated as soon as they appeared above the sand. Others eleven days after sprouting. Inoculations were made by mixing contents of test tubes containing modified Rhizobia with distilled water and pouring contents over the sand near the stems of the plants, so as to allow as much of the fluid as possible to drain along roots and rootlets. About twenty days after inoculation roots were washed and examined. No tubercles were visible. Inoculated plants of corn looked slightly more thrifty than those not inoculated and possessed more fine rootlets. No other differences were visible to the naked eye. Microscopic examination showed, furthermore, that inoculated corn plants were infected by *Rhizobium Frankii*, var. *majus*. (Plate III, 1.) Infection was by no means general. Some of the hair cells were infected, often causing them to bulge at points of infection. Some of the epidermal cells were infected. The most extensive infection took place in parenchyma cells near the vicinity of secondary root formations, without, however, producing any change in the size and form of the cells. Cells were only partially filled with Rhizobia, as seen in the plate. Inoculated corn plants also possessed more hair cells than those not inoculated. No change whatever was noticeable in oat plants.

The reader will please bear in mind that this is a preliminary report only, and that the results of the experiments are far from being conclusive. The following are, however, the probable conclusions from the apparent results obtained

1. Rhizobia of Leguminosae are capable of being sufficiently modified to develop to a certain extent in root cells of corn (*Zea Mays*).

2. Presence of modified Rhizobia produces increased nutritive changes in corn.

3. Presence of modified Rhizobia (modified in corn root-agar extract) has no visible effect upon oats (*Avena sativa*).

BIBLIOGRAPHY.

Most of the references given in the appended list are to books and pamphlets in the library of the Agricultural Experiment Station of the University of Illinois. The list, though not complete, gives the references to the most important treatises touching on the subject of Rhizobia and symbiosis. Starred references are to abstracts or brief reviews. Other references are to original articles.

André, Ann. Chim. et Phys., 6 ser., 1887.
André, Compt. rend., p. 189, 1891.
*André, Exp. Sta. Record, U. S. Dept. Agr., 1892.
Armsby, Penn. Sta. Ann. Report. p. 195, 1889.
*Armsby, Exp. Sta. Record, U. S. Dept. Agr., 1892.
Atkinson, Bull. Ala. Agr. Sta. No. 9, 1889.
Atkinson, Bull. Tor. Bot. Club, June, 1892.
Atkinson, Bot. Gazette, May, June, July, 1893.
*Atkinson, Hedwigia, Heft 4, 1893.
Atwater, Storrs Agr. School, Conn. Sta., 1889, 1890.
*Atwater, Exp. Sta. Record U. S. Dept. Agr., 1890, 1891, 1892.
Bertholet, Ann. de Chim. t. 13, 14, 1888.
Bertholet, Ann. de Chim., 1889; Nov., 1893.
Bertholet, Compt. rend., p. 543, 1889; p. 842, 1893.
*Bertholet, Bot. Ztg., 1890.
*Bertholet, Exp. Sta. Record, U. S. Dept. Agr., 1891, 1892, 1893.
Beyerinck, Bot. Ztg. No. 46–49–50, 1888.
Beyerinck, Akad. d. Wissensch. Amsterdam, 1890.
Beyerinck, Bot. Ztg. No. 52, 1890.
*Beyerinck, Bot. Centralbl., 1891.
Bivona, Pugill. plant. var. siculae, IV, 26, ——
Bolley, Agr. Science, Vol. VII, No. 2, 1892.
Bornet, Ann. d. Sc. Nat., 5 ser., t. XVII, ——
Bouché, Bot. Ztg., 1852.
Breal, Annales Agronomiques, 1888.
Breal, Compt. rend., Oct. 28, 1889.
*Breal, Bot. Jahresbericht, 1891.
*Breal, Exp. Sta. Record, U. S. Dept. Agr., 1892.
Brefeld, Bot. Untersuchungen, 1883.
Brunchorst, Ber. d. deutsch. bot. Ges., 1885.
Brunchorst, Unters. Bot. Inst. Tüb., ——
Buckhout, Penn. Sta. Ann. Report, 1889.
*Buckhout, Exp. Sta. Record, U. S. Dept. Agr., 1892.
Buscalioni, Malpighia I, 1887.
Clos, Ann. d. Sc. Nat. Bot., 1849.
Cohn, Beiträge zur Biologie, 1876.
Conn, Exp. Sta. Record, U.S. Dept. Agr., 1891, 1892.

Cornu, Memoirs d. l'Acad. d. Sc., 1878.
Cornu, Phylloxera, p. 159, 1878.
de Bary, Die Erscheinung der Symbiose, 1879.
de Condolle, Memoir sur les Legumineuses, 1825.
de Condolle, Prodromus Syst. Nat. Reg. Veg., 1825.
de Vries, Landw. Jahrbücher, S. 233, 933, 1877.
de Vries, Landw. Jahrbücher, IV, 1877.
Descaisne, Traité de Bot. Generale, ——
Douliet, Bull. Soc. Bot. de France, Mai, 1888.
*Douliet, Ann. Agronomiques, 1888.
Ericksson, Acta Universitatis Lund., 1873.
Ericksson, Studier öfver Legnmin Rothk., Lund., 1874.
*Ericksson, Bot. Ztg., 1874.
Frank, Bot. Ztg., No. 24 and 25, 1879.
Frank, Ber. d. deutsch. bot. Ges., Heft 4, 11, 1885.
Frank, Unters. Bot. Inst. Tüb. II, 1886.
Frank, Deutsche Landw. Presse, 1886.
Frank, Krankheiten der Pflanzen, ——
Frank, Ber. d. deutsch. bot. Ges., Heft 1, 8, 10. 1887.
Frank, Ernährung der Pflanzen mit Stickstoff, 1888.
Frank, Ber. d. deutsch. bot. Ges., Heft 2, 3, 1888.
Frank, Ber. d. deutsch. bot. Ges., S. LXXXVII, 1888.
Frank, Ber. d. deutsch. bot. Ges., Heft 1, 5, 1889.
Frank, Landw. Jahrbücher, 1890, 1892.
Frank, Lehrbuch, der Pflanzen physiologie, 1890.
Frank, Pilz-symbiose der Leguminosen, 1890.
Frank, Ber. d. deutsch, bot. Ges., 1891, 1892.
Frank, Lehrbuch der Botanik, 1892.
Frank, Deut. Landw. Presse, No. 19, 1893.
*Frank, Ann. d. la. Sc. Agr., 1890.
*Frank, Bot. Centralbl., 1891.
*Frank, Hedwigia, 1892.
*Frank, Exp. Sta. Record, U. S. Dept. Agr., 1892, 1893.
Frear, Penn. Sta. Ann. Report, 1889.
*Frear, Exp. Sta. Record, U. S. Dept. Agr., 1892.
Gain, Compt. rend., No. 24, 1893.
*Gain, Exp. Sta. Record, U. S. Dept. Agr., 1893.
Gautier, Bull. Soc. Chim. d. Paris, t. 7, 8, ser. 3, ——
*Gautier, Exp. Sta. Record, U. S. Dept. Agr., 1892.
Gilbert, See Lawes, Rothamsted Memoirs, 1860.
Gilbert, Jour. Roy. Agr. Soc. England, Vol. II, ser. 3, ——
*Gilbert, Ann. Agronomiques, 1888.
*Gilbert, Exp. Sta. Record, U. S. Dept. Agr., 1892.
Gravis, Bull. Soc. Roy. de Belgique, Sept., 1879.
*Gravis, Revue Mycologique, II, 1880.
Hartig, Vollstäu. Naturgesch. d. Först. Kult., ——
Hartig, Anatomie und Phys. d. Pflanzan, 1891.
*Hartig, Bot. Centralbl., S. 350, 1886.
Heiden, Landw. Jahrbücher, 1874.
Hellriegel, Tagebl. d. Naturz. Versamm, 1886.
Hellriegel, Stickstoff nahr. d. Gram. u. Leg., 1888.
Hellriegel, Ber. d. deutsch. bot. Ges., 1889.
*Hellriegel, Ann. Agronomiques, 1890.
*Hellriegel, Exp. Sta. Record, U. S. Dept. Agr., 1892.
Hiltner, See Nobbe, Versuchs-Sta., 1868.

Hiltner, Sächs. Landw. Zeitsch., No. 16, 1893.
Hotter, See Nobbe, Landw. Versuchs-Sta., 1860.
*Hotter, Exp. Sta. Record, U. S. Dept. Agr., 1892.
Ilosvoy, Bot. Jahresbericht, Heft 2, 1891.
Immendorff, Landw. Jahrbücher, Heft 1, 2, 1892.
*Immendorff, Exp. Sta. Record, U. S. Dept. Agr., 1892.
Jessen, Sitzungsber. d. bot. Ver. d. Prov. Br'n'd'b., 1879.
Johow, Pringsh. Jahrbücher f. Botanik, 1885, 1889.
Kamienski, Bot. Ztg., 1881.
Kamienski, Mem. d. la soc. Nat. Cherbourg, 1882.
Kny, Sitzungsber. d. bot. Ver., Brand., 1877, 1878.
Kny, Bot. Ztg., 1879.
*Kny, Bot. Ztg., 1879.
Koch, Bot. Ztg., 1890.
Koch, Fühling's Landw. Ztg. H. 4, 1892.
*Koch, Bot. Centralbl., 1891.
Koenig, Stickstoff Vorrat, 1887.
Kolaczek, Lehrbuch der Botanik, 1856.
Kraus. Journal f. Landw., 1890.
*Kraus, Exp. Sta. Record, U. S. Dept. Agr., 1892.
Kühn, Landw. Versuchs-Sta., 1863.
Lachmann, Land. Mittheil. Poppelsdorf, 1856.
Lachmann, Centralbl. f. Bak. u. Parasit'k., 1858.
*Lachmann, Exp. Sta. Record, U. S. Dept. Agr., 1892.
Laurent, Ann. d. l'Institut Pasteur, 1889, 1891, 1892.
Laurent, Compt. rend, 1890, 1891.
*Laurent, Bot. Centralbl., 1891.
*Laurent, Exp. Sta. Record, U. S. Dept. Agr., 1892, 1893.
Lawes, Rothamsted Memoirs, 1860, 1862, 1863, 1882, 1883, 1887, 1889, 1890.
Lawes, Jour. Roy. Agr. Soc. Eng., Vol. II, ser. 3, ——
*Lawes, Ann. Agronomiques, 1888.
*Lawes, Exp. Sta. Record, U. S. Dept. Agr., 1892.
Lecompte, Bull. d. la Soc. Bot. France, 1888.
Lemaout, Traité Gen. de Bot., ——
Liebscher, Deutsche Landw. Presse, 1893.
Liebscher, Jour. f. Landw., H. 1, 2, 1893.
Lohrer, Inaug. Dissertation, Marburg, 1886.
Ludwig, Ber. d. Comm. f. Flora Deutsch., 1890.
*Ludwig, Ber. d. deutsch. bot. Ges., H. 12, 1890.
Lundström, Bot. Centralbl., 1886.
Lundström, Pflanzanphys. Studien II, Upsala, 1887.
Lundström, Bot. Centralbl., 1888.
Lupton, Ala. Coll. Sta., 1890.
*Lupton, Exp. Sta. Record, U. S. Dept. Agr., 1891.
Magnus, Sitzungsber. d. bot. Ver., Brandenburg, 1879.
Malpighi, Anat. Plantarum, 1687.
Mattiorolo, Malpighi I, 1887.
Meyer, Ber. d. deutsch. bot. Ges., 1886, 1887.
Mollberg, Jenaische Zeietschr. f. Naturwiss., 1884.
Möller, Ber. d. deutsch. bot. Ges., 1885, 1892.
*Möller, Hedwigia, 1892.
Morck, Uber die Formen der Bakterien, 1891.
*Müller, Bot. Centralbl., No. 14, 1886.
Naegeli, Linnaea, 1842.
Newman, Ala. Coll. Sta., Bull. No. 16, 1890.

*Newman, Exp. Sta. Record, U. S. Dept. Agr., 1891.
Nobbe, Landw. Versuchs-Sta., 1868, 1890, 1892.
Nobbe, Sächs. Landw. Zeitschr., 1893.
*Nobbe, Exp. Sta. Record, U. S. Dept. Agr., 1892, 1893.
Otto, Ber. d. deutsch. bot. Ges., 1890.
*Otto, Ann. Agron., 1890.
*Otto, Exp. Sta. Record, U. S. Dept. Agr., 1892.
Pagnoul, Ann. Agron., 1890.
*Pagnoul, Exp. Sta. Record, U. S. Dept. Agr., 1892.
*Petermann, Chem. Centralbl., 1892.
*Petermann, Exp. Sta. Record, U. S. Dept. Agr., 1893.
Phelps, Storrs Agr. School, Conn., 1890.
*Phelps, Exp. Sta. Record, U. S. Dept. Agr., 1892.
Pichi, Atti del Soc. Toscana, Sc. Nat., 1888.
Pickard, Compt. rend., 1892.
*Pickard, Exp. Sta. Record, U. S. Dept. Agr., 1892.
Pirotta, Malpighia, 1888.
Prazmowski, Bull. d. Akad. d. Wiss., Krakan, 1889.
Prazmowski, Landw. Versuchs-Sta., 1890.
*Prazmowski, Bot. Centralbl., 1888.
Prillieux, Ann. d. Sc. Nat., 1856.
Prillieux, Bull. Soc. Bot. France, 1879, 1888.
*Prillieux, Bot. Centralbl., 1891.
Pringsheim, Jahrbücher, XVI, ——
Rautenberg, Landw. Versuchs-Sta., 1863.
Rees, Ber. d. deutsch. bot. Ges., 1885.
Reinke, Flora, 1873.
Reissek, Ueber die Endophyt. d. Pflanzen, 1846.
Salfeld, Deutsch. Landw. Ztg., 1890.
Salfeld, Deutsch. Landw. Presse, 1891.
*Salfeld, Exp. Sta. Record, U. S. Dept. Agr., 1892.
Schacht, Monatsber. d. Berl. Ak. d. Wiss., 1854.
Schindler, Oest. Landw. Wochenbl., 1885.
Schindler, Jour. f. Landw. Henneberg, 1885.
Schlicht, Landw. Jahrbücher, 1889.
Schlicht, Bot. Jahresbericht, 1891.
Schloesing, Compt. rend., 1890, 1891.
Schloesing, Ann. d. l'Institut Pasteur, 1892.
*Schloesing, Bot. Centralbl., 1891.
*Schloesing, Exp. Sta. Record, U. S. Dept. Agr., 1892, 1893.
*Schmid, Exp. Sta. Record, U. S. Dept. Agr., 1892.
Schmid, See Nobbe, Versuchs-Sta., ———
*Schmitter, Exp. Sta. Record, U. S. Dept. Agr., 1892.
Schneider, Bull. Tor. Bot. Club, 1892.
Schneider, Am. Naturalist, Sept., 1893.
*Schneider, Hedwigia, 1892.
*Schneider, Revue Mycologique, 1893.
*Schneider, Bot. Centralbl., 1893.
Schroeter Natürlichen Pflanzanfamilien, 1890.
Schulze, Landw. Jahrbücher, 1890.
Serno, Landw. Jahrbücher, H. 6, 1889.
Sorauer, Pflanzenkrankheiten, 2te. Aufl., 1886.
*Sorauer, Bot. Centralbl., 1887.
Strecker, Jour. f. Landw., 1886.
Thaer, Jour. f. Landw., 1879, 1884.

Tollens, Landw. Versuchs-Sta., 1891.
Treviranus, Bot. Ztg., 1853.
Troschke, Landw. Versuchs-Sta., 1884.
Troschke, Biedermann's Centralbl., 1884.
Troschke, Wochenschr. d. Pomm. Ok. Ges., 1884.
Tschirch, Ber. d. deutsch. bot. Ges., H. 2, 5, 1887.
Tschirch, Centralbl. f. Bak. u. Parasit'k'de., 1887.
Tschirch, Ges. naturw. Freunde, Berlin, 1887.
*Tschirch, Ann. Agron., 1888.
*Tschirch, Forch. auf. d. Gebiete d. Agr., 1888.
Van Beneden, Archives de Biologie, 1880.
*Van Tiegham, Ann. Agron., 1888.
Van Tiegham, Bull. d. la Soc. Bot., 1888.
Vibranes, Deutsche Landw. Presse, 1893.
Vines, Ann. of Bot., 1888. 1889.
Vogel, Jour. f. Landw., 1890.
Vuillemin, Jour. d. Bot.. 1888.
Vuillemin, Ann. d. Sc. Agr., 1888.
Wahrlich, Bot. Ztg., 1886.
Ward, Phil. Transac. Roy. Soc., London, 1887.
Ward, Ann. of Bot., 1888.
Ward, Proceedings Roy. Soc., London, 1889.
*Ward, Biedermann's Centralbl., 1888.
*Ward, Ann. Sc. Agron., 1888.
Warington, U. S. Exp. Sta., Bull. No. 8, 1892.
*Warington, Exp. Sta. Record, U. S. Dept. Agr., 1892
Warming, Bot. Jahresber., 1876.
Weber, Bot. Ztg., 1884.
Wigand, Forch. a. d. bot. Gar. z. Marburg, 1887.
Willfarth, Beilageh. z. Rübenz. Indus., Nov., 1888.
Willfarth, Deutsche Landw. Rundschau, Nos. 8, 9, 10, 11, 1892.
*Willfarth, Ann. Agron., 1888.
*Willfarth, Bot. Centralbl., 1889.
*Willfarth, Chem. Centralbl., 1893.
*Willfarth, Exp. Sta. Record, U. S. Dept. Agr., 1893.
Wittmack, Verh. d. Bot. Ver., Brandenburg, 1874.
Wolff, Brand des Getreides, 1874.
Woods, Storrs Agr. School, Bull. No. 5, 1889,
Woods, Storrs Agr. School, Conn., p. 44, Rep't, 1890.
*Woods, Exp. Sta. Record, U. S. Dept. Agr., 1890, 1891, 1892
Woronin, Mém. d. l'Acad. d. Sc., No. 6, 1866.
Woronin, Ann. sc. nat., 1867.
Woronin, Pringsheim's Jahrbücher, 1877, 1878.
Woronin, Ber. d. deutsch. bot. Ges., 1885.
Woronin, Mém. Acad. Imp. d. Sc., 1886.
*Woronin, Bot. Centralbl., 1889.
Zopf, Die Pilze, 1890.

ALBERT SCHNEIDER.

EXPLANATION OF PLATES.

PLATE I.—1. Longitudinal median section of portion of rootlet and developing tubercle of *Trifolium Pratense.* (*a*) Normal hair cells. (*b*) Hair cell infected by Rhizobia. (*c*) Dwarfed hair cells on tubercle. (*d*) Epidermal layer. (*e*) Infected area of tubercle. Cells are enlarged containing Rhizobia, *Infektionsfäden*, and abnormally large nuclei. (*f*) *Infektionsfäden* containing smaller Rhizobia. (*Rhizobium Frankii?*). (Left colorless in this figure). (*g*) Apical area of tubercle. Subsequent development of the tubercle is outward from this area. (*h*) Area from which the vascular system of the tubercle will arise. (*i*) Vascular system of rootlet.

2. Semidiagramatic figures showing probable mode of the growth and extension of the *Infektionsfäden* in the infected area of tubercle.

I. Single cell from the apical area of tubercle. (*a*) The beginning of an *Infektionsfäden*. It is simply a group of Rhizobia surrounded by a coating of cellulose secreted by the cell cytoplasm. (*b*) Another group of Rhizobia differing from those of (*a*). They freely mix with the cell cytoplasm and do not have a coating of cellulose deposited around them. (Example, *Rhizobium mutabile.*) (*n*) Neuclus of cell.

II. Later stage of the same cell. Groups (*a*) and (*b*) are enlarged. The nucleus has begun to divide.

III. Later stage than II. The new cell wall (*c*) has begun to form, passing through both groups of Rhizobia.

IV. Complete cell division. Two autoinfected daughter cells have developed from the mother cell. As is seen, the *Fäden* are not of the same thickness throughout. Local increase in the development of Rhizobia causes swellings. This is nearly always the case next to the new cell wall (III and IV).

V. Group of mature cells from infected area. (*a*) *Infektionsfäden* filled with Rhizobia (*Rhizobium Frankii?*). (*b*) *Rhizobium mutabile* filling remaining portion of cell and intimately mixed with cell cytoplasm forming the mycoplasm of of Brunchorst and Frank.

3. Small portion of root of *Melilotus alba* with tubercles. (*a*) Developing tubercles. (*b*) Later stage showing dichotomous mode of branching of tubercle. (*c*) Single mature tubercles. (*d*) Grape bunch-like group of tubercles. Very common with Melilotus.

[1 and 2, highly magnified; 3 is natural size.]

PLATE II.—1. Peculiar Rhizobia sparingly present in infected cells of tubercles of *Petalostemon violaceus*. As a rule, each cell contains three or four of these organisms.

2. *Rhizobium mutabile* of Trifolium (clover). (*a*) Spores. (*b*) Developing spores.
3. *Rhizobium mutabile* of *Melilotus alba* (sweet clover). (*a*) and (*b*) as in 2.
4. *Rhizobium mutabile* of Trifolium, later stage.
5. *Rhizobium curvum* of Phaseolus (bean).
6. *Rhizobium Frankii*, var. *majus*, of *Phaseolus vulgaris*.
7. *Rhizobium Frankii* of Infektionsfäden of Melilotus, Trifolium, and other genera of plants.
8. *Rhizobium Frankii*, var. *minus* of Pisum (pea) *Infektionsfäden*. (*a*) Spores and young Rhizobia with cilia.
9. *Rhizobium spheroides* of *Pisum sativum*. They often contain highly refractive bodies the function of which is undetermined.
10. *Rhizobium nodosum* of Cassia (partridge pea).

[Highly magnified.]

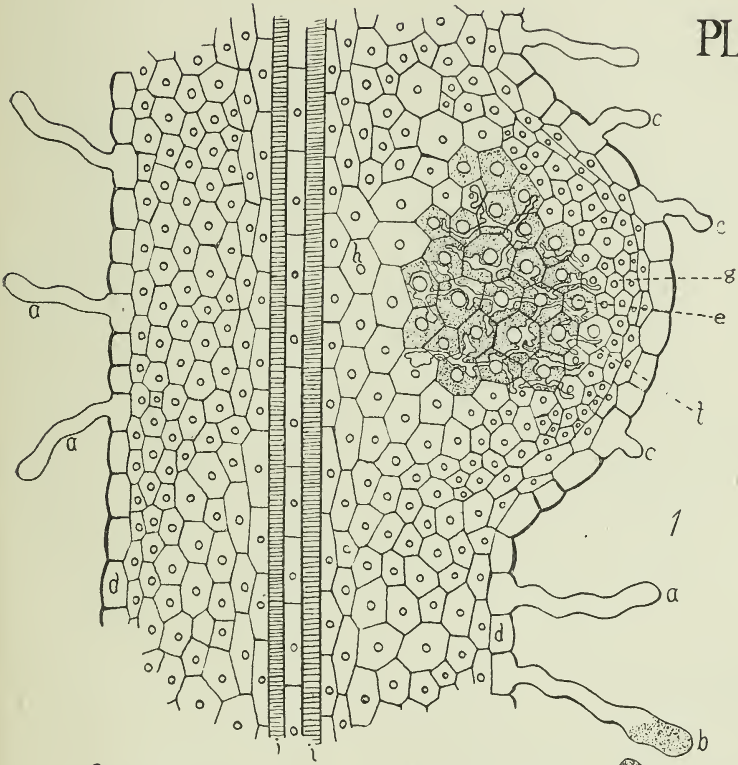
PLATE III.—1. Longitudinal section of portions of inoculated corn (*Zea Mays*) rootlet. (*a*) Hair cells infected by modified Rhizobia. Cells become somewhat enlarged at points of infection. (*b*) Parenchyma cells infected by modified Rhizobia; cells remain unchanged. (*c*) Secondary rootlet.

2. *Rhizobium mutabile* cultivated upon bean and corn root extract.
3. *Rhizobium mutabile* cultivated upon corn root extract.
4. *Rhizobium mutabile* cultivated upon sweet clover root extract.
5. *Rhizobium mutabile* cultivated upon sweet clover extract prepared from stems and leaves.

All culture media were solidified by agar-agar.

[Highly magnified.]

PLATE I.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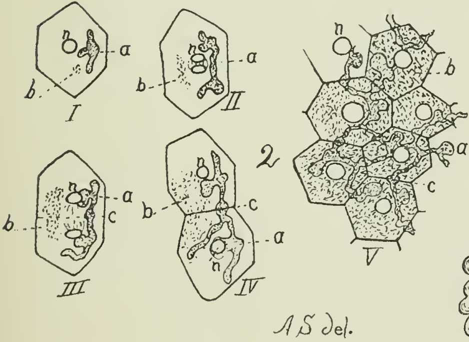
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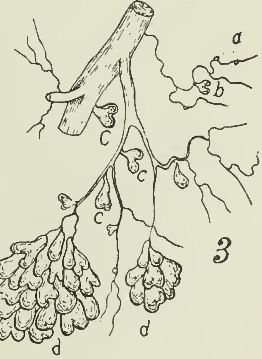
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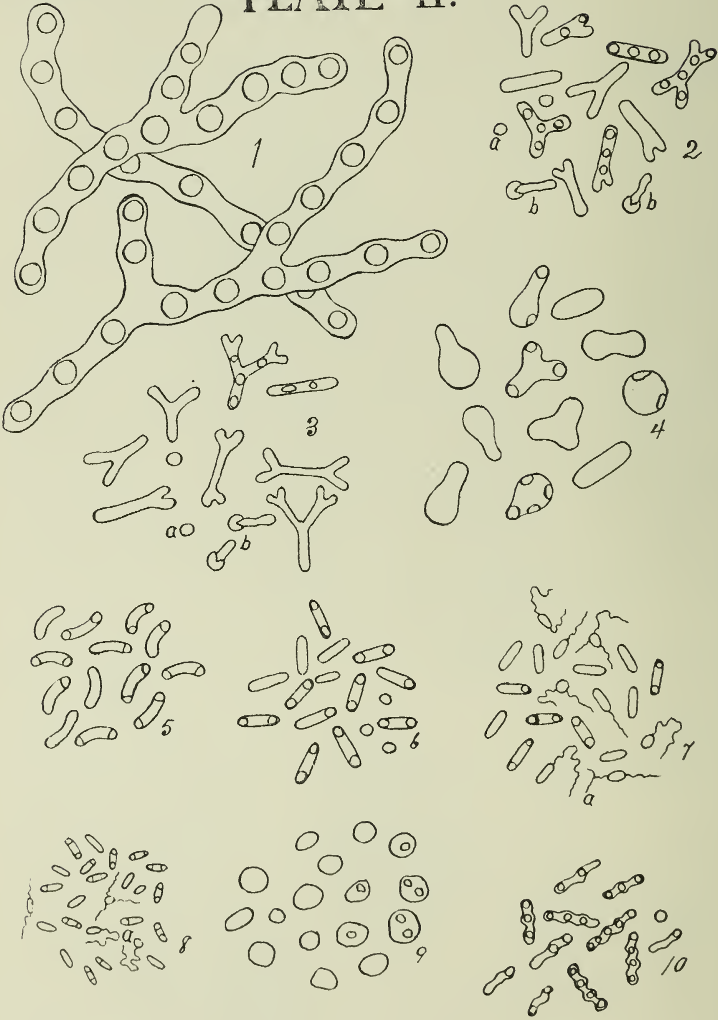

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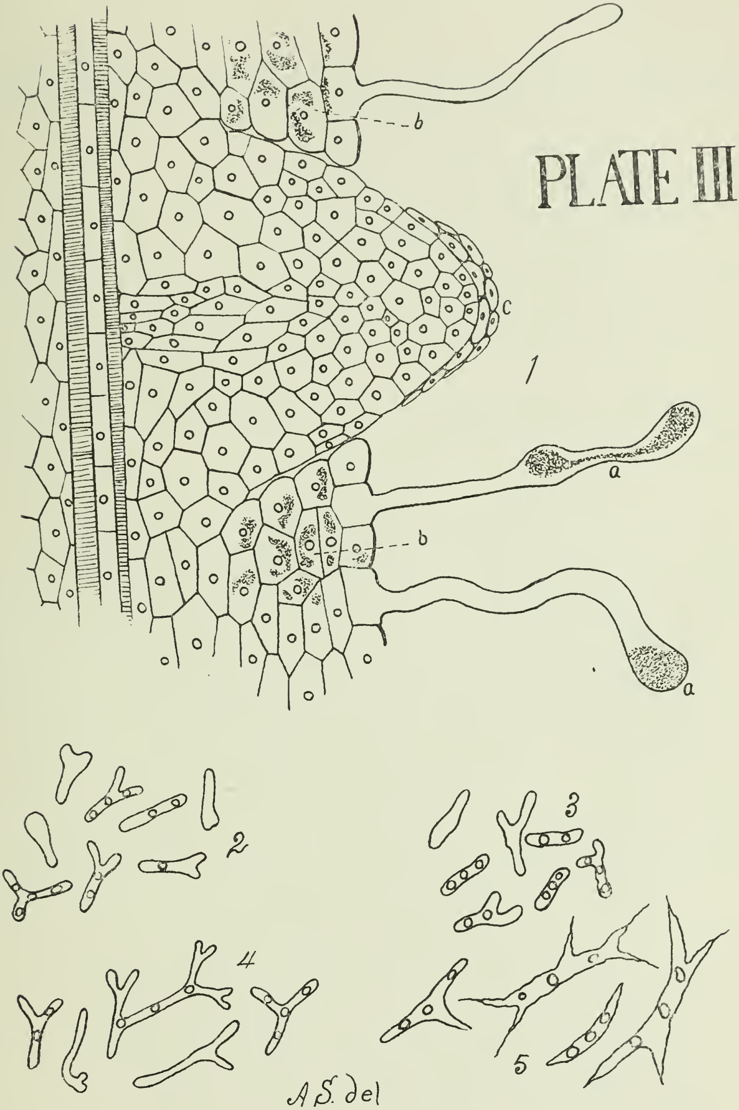
PLATE III.



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UNIVERSITY OF ILLINOIS.

Agricultural Experiment Station.

CHAMPAIGN, MARCH, 1894.

BULLETIN NO. 30.

Blackberries and Raspberries, Variety Tests, and Management.

Experiment No. 43. Blackberries, Test of Varieties.

The first of the blackberries—Snyder, Erie, Early king, Missouri mammoth, Wilson's early, Wilson Jr., and Minnewaska—were planted in the spring of 1889. Of the others described in this bulletin—Wachusett thornless, Early cluster, and Freed, were planted in 1891, and the rest in 1892. The varieties are each in a single row, and, where enough plants were obtained, the row is four rods long, 25 plants being set in the four rods. Those planted in 1892 have not been out long enough to form an accurate estimate of them.

Part of the land is low and apparently of a character not suited to the blackberry. The test on that account is not so reliable as it would otherwise be. The land is well drained with tile, so that the lowest ground is the first that is fit for cultivation in spring. The surface, on exposure to the weather during winter, becomes finely pulverized and looks almost like ashes. If this land is turned up to a depth of eight inches, a gummy soil is thrown on top that breaks into larger or smaller angular lumps that become very hard on drying and will rattle almost like gravel when struck with a hoe, and it retains that character all summer. By the next spring it is in the condition that the previous surface soil was, and what was surface soil has again taken on the gummy and semi-crystalline nature of the subsoil. The plants on this lower ground have not grown so well as on higher land of a different character, and the fruit has dried up much worse during the drouths of summer. The Snyders during the severe drouth of last summer were not near so large, juicy; or so good in quality on this low land as they were on higher ground not more than twenty rods away. Under otherwise the same conditions 78 of the berries grown on the higher ground weighed as much as 100 of those grown on the low ground. The Snyders are on the lowest ground and seem to have been most affected. All those planted the first season would undoubtedly be better if on a different soil.

There is no record of the land having been manured. It had been in meadow and pasture for several years previous to 1888. It was broken up in the spring of that year and allowed to lie idle until planted to blackberries and raspberries in 1889.

The blackberries have never had any mulch, manure, or winter protection. They have had thorough level cultivation from early spring until the latter part of summer. The plants have been kept closely confined to the rows, but have not been thinned much in the row, probably not so much as would have been best for the production of good fruit. The new shoots have been pinched back when about 2½ feet high and have had no further pinching or pruning until the following spring, when the branches or laterals thrown out after pinching have been cut back to from one to two feet in length. This is a method of thinning the fruit on plants that are liable to overbear. Some varieties, as the Snyder and Minnewaska, will frequently bear more fruit, with even that amount of cutting back, than they can ripen well, while some of the other varieties could ripen more fruit than they would set, even if they were not cut back at all.

There is a natural difference in the hardiness of the varieties of blackberry. In those tested, Snyder and Minnewaska have seemed most hardy, and Early harvest and Crystal white least. The condition of health of the plant will, without doubt, make a difference in its ability to withstand cold as well as other unfavorable conditions. The Wilson's early, Wilson Jr., and Erie have so far been most subject to disease.

DESCRIPTIONS OF VARIETIES.

SNYDER.—Plant, a very strong, upright grower, not branching unless tipped, stiff; spines, straight, stiff, not numerous; very hardy. Leaf and stem comparatively free from disease. The young shoot usually comes from the side of the old cane, and so is very liable to break down with the load of fruit, unless the row is somewhat ridged. Berry, large, oblong, glossy; grain, large; seed, very large and firm. The berry colors two or three days before it is at its best for use, and is usually picked about as soon as well colored. It is then sour, has a hard core, and has not attained nearly its full size. When fully grown and ripe the berry is sweet, rich, and has entirely lost the hard core which it had only two days before. Cluster, large and rather open.

The Snyder is grown more largely than any other variety, and is deservedly popular as a market variety in the same sense that the Ben Davis apple is popular. It is a regular and very heavy bearer. The fruit has seemed more liable to dry up on the bush than that of other varieties, perhaps because of the heavy bearing.

The Snyder is a variable variety, but whether from bud variation or from seedling plants that come up along the rows, it is impossible to say. For the past two years we have allowed all seedlings that appeared in the rows to live as long as they would, but both years all were dead before the middle of the summer. This, however, does not prove that numerous seedlings have not grown. Some difference has been found in the appearance of the fruit, but little or none in the quality; and there has been frequently a difference of two or three days, in one instance as much as a week's difference, in the time of ripening.

MINNEWASKA.—This variety has been obtained from two sources under the name of "Ancient Britton." The plant is a good grower, erect, branching, strong; stems, stiff, sharply angled, and very thickly covered with long, straight spines. It has so far seemed perfectly hardy; leaf and stem, free from disease. The cluster of fruit is long, compact, and very full; 25 to 30 berries in each. Berry, large, long, dull in color, with the pistils adhering and giving the fruit a hairy appearance; somewhat sour, and of inferior quality; core, rather firm; seed, large. Its season is two or three days later than Snyder. This has been the most productive variety grown so far. The weight of the fruit frequently makes the plant hang down to the ground. It does not suffer so much from drouth as the Snyder, and would seem to be a valuable variety for market, as it would carry well, and but little attention is usually paid to anything more than the fact that it is a blackberry in good shape.

ERIE.—The plant is one of the most vigorous growers; cane, upright until it reaches a height of two or three feet, then growing over sideways, not very strong; spine, large and stiff. More subject to disease than the Snyder. Cane somewhat subject to anthracnose, and the lower leaves liable to be attacked by a brown rust (*Septoria rubi*), commonly called spot disease, that causes them to fall early in the season. Cluster, of medium size, 8 to 10 berries. Berry, large to very large, smooth, glossy, of good quality; grain, very large; seed, large and firm; core, soft when fully ripe. A large part of the blossoms fail to set any fruit, and many of the berries are very imperfect. The variety is not so hardy as Snyder; its season is 3 to 4 days later, and it is a comparatively shy bearer as grown here, yielding but about one-third as much as the Snyder or Minnewaska.

WILSON JR., AND WILSON'S EARLY.—As grown here there has not been enough difference in these two varieties to separate them.

The plant has been a good grower, with drooping stem and numerous small, recurved spines. The stem is very subject to anthracnose; and the leaves to the spot disease, which takes them off below before the fruit has begun to ripen. The plants winter-kill and would need protection here during cold winters. Most of the fruit is borne on shoots which come from the ground the same year. Not more than one-half the blossoms set any fruit, and most of that is very imperfect. The perfect berries on shoots from the ground are of largest size; the others, only medium. From our experience this variety is entirely unworthy of further attention here, though very flattering reports are heard from it in other places. Plants bought for "*Stone's hardy*," have proved to be the same as these.

MISSOURI MAMMOTH.—Plant, a moderate grower, nearly free from disease, upright; spine, medium size, recurved. Fruit, cluster of medium size, with 8 to 10 berries. Blossoms do not all set fruit, and some of the berries are imperfect. Berry, large, oval, fair in quality; grain and seed, large; core, soft when fully ripe. Its season is three to four days after Snyder, and it is a comparatively shy bearer. It has not proved entirely hardy and could not be recommended.

WACHUSETT THORNLESS.—The plant is a slow grower; stem grows upright at first but soon becomes drooping; spines, few and small. The stem is very subject to anthracnose, and is somewhat liable to winter-kill. The leaf is subject to the brown rust. The clusters of fruit are few and small, six to ten berries in each. Berry, small, round, not well filled, of very good quality; seed, large. Season, about one week later than Snyder. This is the poorest bearer among the blackberries and not worthy of a place anywhere.

LOVETT'S.—The cane is strong, upright, but slightly angled, dark purple, very free from disease; spines, few and small; leaf, comparatively healthy. The fruit cluster is small, 8 to 10 berries, compact. Berry, rather small, round, well filled, with little core; quality, very good to best. The seed is large and very firm. It seems to be a very shy bearer, but has borne one crop of fruit only and may improve with age as some varieties seem to do. From present experience it could not be recommended.

KITTATINNY.—Plant, an upright, rather strong grower; stem somewhat subject to anthracnose, has the reputation also of not being entirely hardy, and of being subject to the red rust, though it has not shown the latter disease here. The fruit cluster is large and open. Berry, large, oblong, glossy; no core when fully ripe; quality, very good. Its season is the same as Snyder. It is not so apt to be injured by the drouth as the Snyder, and is better in quality, with smaller seeds. It is a moderate bearer. It could not be recommended for general planting.

EARLY KING.—The plant is a rather small grower, erect, stiff, with several small canes making a thick clump from each stool, and with large spines; nearly free from disease but subject to winter-killing. The cluster of fruit is of medium size. Berry, medium size, oval, not regular in shape, not promising in appearance, but one of the best in quality; core, soft. It attains its full size and perfect quality as soon as colored. Its season is fully a week earlier than Snyder. It yields fairly well, is not so hardy as Snyder, about one-half the wood being killed by the cold of 1892-3, when the lowest temperature was —21½° F. It would be recommended for an early variety for this latitude.

EARLY HARVEST.—The plant is a moderate grower, upright, with some tendency to branch without tipping; wood, light colored; has so far been nearly free from disease, but is one of the most tender varieties tested. About nine-tenths of the wood was killed during the winter of 1892-3. Spines, few and small. Fruit cluster, medium size, 12 to 15 berries. Berry, small to medium size, oblong, glossy, smooth; quality, very good to best; grain, very small; seed, small, not hard. It has a soft core when fully ripe. Its season is about ten days earlier than the Snyder. It promises to be very productive, if it can have winter protection, and its season and quality would make it valuable for home use or market.

LINCOLN.—The plant is a good grower, upright, strong; spine, long and stout. It has so far been entirely free from disease. The fruit cluster is large and rather open. Berry, large, oblong, glossy, juicy, of good quality; grain and seed, large. Its season is 3 or 4 days later than Snyder. It seems to be perfectly hardy here. It has not been planted long enough to come into full bearing. It has been condemned in some places where tried and highly praised in others.

CRYSTAL WHITE.—A moderate, upright grower, branching readily without being tipped. It is very thorny, and the canes are more subject than in most varieties to anthracnose. This is a very tender variety, killing back worse than Early harvest. The fruit cluster is small. Berry, small, oblong, white; core, soft; taste, pleasant, sweetish; not of high quality. Its season is somewhat later than Snyder. It has so far been a very shy bearer, and would be of no value except as a curiosity.

FREED.—The plant is a rank, upright grower, has few spines, is very hardy, and has been free from disease. The fruit cluster is rather small. Berry, small to medium size, oblong, juicy; quality, very good. Its season is nearly the same as Snyder. It has been a very shy bearer and is not recommended for any purpose.

EARLY CLUSTER.—The plant is a medium grower, very upright, rather slender, very thorny. The stem shows some anthracnose, and the plant is not entirely hardy. The fruit cluster is small. Berry, small to medium, nearly round, of very good quality; core, soft. Its season is nearly the same as Snyder. The fruit does not set well and it has proved to be a very shy bearer. It is not worthy of recommendation.

JEWETT.—The plant is a moderate, upright grower, with a few small spines. Cane, not entirely hardy and more subject to anthracnose than in most varieties. Fruit cluster, small. Berry, small, round, juicy, sour, with a hard core and large seeds. The season is 2 to 3 days later than Snyder. It is a very shy bearer, and could not be recommended.

LUCRETIA.—This is a dewberry and does not grow upright, but trails on the ground. Stem, small and slender; spines, few, small, recurved. The plant is somewhat subject to anthracnose, and the leaf to the spot disease. Fruit cluster, large, open, with 6 to 8 berries. Berry, very large, not well filled, oblong, sour, and poor in quality as grown on our soil; core, rather firm. Its season is 6 to 8 days earlier than the Snyder. From our experience it would seem almost worthless, but it has done better with others in the vicinity, though not a profuse bearer with any. In other localities it is highly recommended both for quality and productiveness. It seems to be of more value in the southern than in the central or northern part of the state.

Experiment 44. Raspberries, Test of Varieties.

The raspberries were planted along with the blackberries, though none of them in the low ground described on page 321. The plats, as described under blackberries, consist each of a single row four rods long, where enough plants were obtained to fill out so much. In 1889 the following varieties were planted; Cuthbert, Turner, Brandywine, Golden queen, Rancocos, Early pride, Hansell, Philadelphia, Marlboro, Naomi, Carman, Springfield, Gregg, Mammoth cluster, Johnson's sweet, Hilborn, Shaffer's and Nemaha. In 1890, Hornet, Hudson River Antwerp, Reliance, Herstine, Clarke, American black, Palmer, Muskingum, and Lovett's black were planted; and in 1892, Stayman's No. 5, Kansas, Caroline, and Crimson beauty.

The cultivation has been the same as described for blackberries. The new shoots of the black raspberries are tipped when from 2 to 2½ feet high and are then allowed to grow without further pruning until the spring following, when they are cut back, leaving the laterals from 12 to 15 inches long. This gives a compact bush that stands well without support of any kind. We have made it a practice, as soon as the fruiting season is over, to take out all the bearing wood. There is some question as to whether or not this is the best plan. A row left in 1892, without taking out the old wood until the next spring, yielded more fruit than those on each side of it from which the old wood was removed as soon as the fruit was off. The question of time for taking out the old wood is now undergoing a test on a larger scale than last year and more definite results may be expected.

The red raspberries have been kept in close rows, with some thinning in the row. The plants have not been tipped during summer but the tallest ones have been cut back somewhat early in the spring.

All the European varieties of raspberries, as grown here, are very subject to the spot disease (*Septoria rubi*) of the leaves. It attacks the older leaves first, soon causing them to drop, and by fall many of the varieties have only small tufts of leaves at the tops of the new canes.

Plants so diseased are very likely to die during the winter or before the fruit is ripened the next season. The Clarke is perhaps as free from the disease as any of them.

The American red raspberries have so far seemed more subject to anthracnose than to the spot disease, the canes of some of the varieties being so badly infested as to render them almost worthless. Turner, Cuthbert, and Golden queen have been as free from diseases as any of the red raspberries.

DESCRIPTION OF VARIETIES.

Black Varieties.

AMERICAN BLACK.—The plant is a rather small grower, and is very subject to anthracnose. The berry is small and often imperfectly filled, not juicy, of fair quality; grain, of medium size, with large seeds. The records show it to have been a very shy bearer. Its season is about 2 or 3 days earlier than Gregg. It could not be recommended.

CARMAN.—The plant is a moderate grower, and has so far been comparatively free from disease. The berry is of medium size, juicy, firm, slightly acid but of good quality; grain, small; seed, small. It has been a very fair bearer. Its season is about 5 to 6 days earlier than Gregg, and it lasts longer. This would be an advantage in a berry for home use, but not in one for market.

GREGG.—The plant is a very strong grower, is hardy, and has been comparatively free from disease. The berry is very large, firm, not juicy, of only moderate quality. The bloom, or down, gives it more of a grayish appearance than other varieties have. The grain is large, and the seed very large. It is classed as a late variety, and is one of the most productive.

The Gregg is probably grown more extensively than any other variety, and, like the Snyder blackberry, seems to have become somewhat variable. There will frequently be seen a difference of two or three days in the season of ripening, and some of the plants bear fruit much more poorly filled than others, while the other characters of the plant and fruit seem the same as the typical Gregg. This is another case in which it is impossible to say whether or not the variations have come from seed. The attempt is making to see whether the variations can be perpetuated.

CONRATH'S EARLY.—The plant is a very good grower, and has so far been free from disease. The berry is above the medium size, firm, moderately juicy; quality, good. The grain and seed are of medium size. Its season is 3 to 4 days earlier than Gregg. It is not so productive as the best but is up to the average. This is a new variety not yet introduced.

HILBORN.—The plant is a good grower, fairly free from disease, and seems quite hardy. The berry is of medium size, rather soft, juicy, very good in quality; grain, of medium size; seed, small. It has been more productive than the average black raspberry. Its season is fully a week earlier than Gregg, and it lasts longer than that variety. It would be recommended for home use or a near market.

JOHNSON'S SWEET.—The plants seemed to be good growers for the first two or three years, but afterwards they gradually died out from no apparent cause. The berry is of medium size, juicy, sweetish, rather rich; quality, very good. The grain and seed are of medium size. When the plants first came into bearing they seemed to be very productive. The variety ought to be of value if frequently renewed. Its season is about 3 days earlier than Gregg, and it lasts nearly as long as that variety.

NEMAHA.—There seems to be no reason for classing this or *Naomi*, as we have them, as different from Gregg.

Kansas.—The plant is a rank, strong grower, and has so far been free from disease. It seems perfectly hardy. The berry is large, firm, moderately juicy, very good in quality. The grain and seed are large. Its season is about a week earlier than Gregg, and it is one of the most productive varieties. It should have a high rank either for home use or market on account of its appearance, productiveness, and season. This is a new variety that seems to sustain the claims made for it.

Palmer, Acme Palmer.—This variety was sent out about six years before the Kansas. It is a day or two earlier than that variety and somewhat smaller, but is otherwise very similar to it. It is one of the best of the early black raspberries.

Lovett.—A variety of recent introduction, it has so far been a complete failure.

Mammoth cluster.—The plant is a good grower, fairly free from disease, and comparatively hardy. The berry is small to medium size, apt to be poorly filled, moderately juicy, very good in quality. The grain and seed are of medium size. Its season is nearly a week earlier than Gregg. It has been a moderate bearer. This is one of the old varieties that are nearly superseded by newer and better ones.

Progress.—This variety has not been grown long enough to decide its merits, but it seems to give little promise. The plant is a small grower, the fruit is small and not abundant.

Springfield.—The plant is a very weak grower and is more subject to disease than any other variety. Berry small, firm, not juicy; grain and seed, small. A shy bearer. Of no possible use here.

Red Varieties.

Brandywine.—Plant, not a good grower; cane, rather slender, about 3 to 3½ ft. high, erect, yet when full of fruit bending almost to the ground. The tips, at least, are subject to anthracnose. Berry large, slightly conical, purplish red, juicy, moderately firm, scarcely of good quality; grain and seed, large. Clusters, compact on a slender, drooping stem. This is a late variety, about with Cuthbert in season, and is not a good bearer. It would not be recommended.

Caroline.—The plant is a moderate grower, 2½ to 3 ft. high, not erect; cane, rather slender, with more spines than is common to the red raspberry group; comparatively free from disease. Berry, of medium size, yellow, shaped like the blackcap, juicy, soft, rather acid, of good quality; grain, large; seed, of medium size. Fruit cluster, compact and well filled. Its season is 3 to 4 days earlier than Cuthbert. It has been a fair bearer and seems hardy, but there are other varieties more desirable. Yellow raspberries are not popular.

Clarke.—One of the European red raspberries. The plant is a moderate grower; cane, rather slender and comparatively free from disease. The leaves are subject to the spot disease that takes most of them off before the middle of summer, and by the latter part of the season the canes bear only a small tuft of leaves at the top. As a result, the wood is poorly ripened and easily winter-killed. The same statement with regard to disease of leaves would be true for all the European varieties tried here, and the rest are worse diseased than this one. Berry, large, conical purple when fully ripe, firm, meaty, mild acid, slight peach flavor; grain, large; seed, large. Its season is about 3 to 4 days earlier than the Cuthbert. It might be valuable were the plants healthy and hardy.

Crimson beauty.—Plant a good grower and comparatively free from disease. Berry, large, round, bright crimson; grain and seed very large. Not more than one berry in a hundred is well filled; most have but one or two grains. Of no value.

Cuthbert.—Plants grow erect and strong, 4 to 6 ft. high, and are usually comparatively free from disease. Berry, very large, reddish purple, oblong, conical, firm, juicy; quality, very good but harsh, rather sour; grain and seed, medium size, This is one of the late red raspberries, and for a market variety stands at the head of the list. It has not been so productive here as some others.

EARLY PRIDE —The plant is a rather small grower; cane, slender, erect, 2½ to 3 ft. high, hardy, and comparatively free from disease. The berry is of medium size, round, light red, rather soft, juicy, very good in quality, mild, and pleasant; grain and seed, of medium size. This is the earliest of the red raspberries, coming in 3 to 4 days earlier than Turner and about 10 days ahead of Cuthbert, being nearly gone before the latter variety begins to ripen. It yields very well and would be recommended for home use or market to lengthen the season.

GOLDEN QUEEN.—This might be described as a yellow Cuthbert. The plant scarcely grows so tall as the Cuthbert, but the fruit is practically the same in every way except color.

HANSELL.—The plant is rather low growing and unless grown very thick is bushy and somewhat slender. Very subject to anthracnose in all parts of the stem, even the fruit stems and sometimes the fruit itself being attacked. Berry of medium size, round, reddish purple, not always well filled, juicy; quality, very good; grain and seed, large. Its season is about two days earlier than Turner. It has yielded fairly well so far, but, on account of its liability to disease, other varieties are to be preferred.

HORNET, AND HUDSON RIVER ANTWERP.—The leaves have rusted and fallen off so badly that these varieties have been a complete failure.

HERSTINE.—The plant is a rather small, upright grower, 2½ to 3 ft. high, hardy; cane, somewhat slender, bending down when loaded with fruit, comparatively free from disease. Berry, large, round, purplish red, moderately firm, juicy; quality very good, acid, not harsh; grain, large; seed, of medium size. Its season is 2 to 3 days earlier than Turner and it bears fairly well.

MARLBORO.—Plant, a rather low grower; cane, stiff and erect; too much subject to disease. The edges of the leaves are curled down in a way that would distinguish the variety readily from others. Berry, very large, conical, pale red, firm, juicy, mild, pleasant, not rich in quality, of fine appearance; grain, large; seed, of medium size. Its season is the same as Turner. It is not recommended.

MUSKINGUM.—Plant, a medium grower, subject to anthracnose, and not entirely hardy. Berry, large, shaped like the blackcaps, firm, purple, with a harshness that is not agreeable to most tastes; grain and seed, large. Its season is about the same as Cuthbert. Only moderately productive. Not recommended.

PHILADELPHIA.—Plant, a moderate grower, bushy, hardy, comparatively free from disease, and seems to be less influenced by drouth than most other varieties. Berry, rather small, reddish purple, juicy; quality, very good; grain and seed, large. Its season is the same as Cuthbert. This has been the most productive variety grown so far, but its small size makes very tedious picking, and, on account of its small size, it does not sell so well as some of the other varieties.

RANCOCOS.—Plant, a weak grower, very subject to anthracnose, not entirely hardy; plants that do live over winter, liable to die before they ripen their fruit. Berry, reddish purple, small, shatters to pieces easily, juicy, harsh. One of the very early varieties, but a poor bearer and of no value here.

RELIANCE.—The plant is a rather slender grower, becoming thick and bushy; canes, fruiting stems, and berries, apt to be badly injured with anthracnose, and leaves subject to the spot disease. Berry, medium to large, purple, round, moderately firm, juicy, acid, rather harsh to the taste, would be classed as good in quality; grain and seed, large. Its season is only a day or two later than the Turner. If plants could be had free from disease, it would be a very productive variety; as it is, we could scarcely recommend it.

SHAFFER'S.—This variety is by some considered as a hybrid between the black and red raspberries and by others as the representative of a distinct species. The plant is a very strong, upright grower; cane, thickly covered with small spines, somewhat subject to anthracnose. It has so far been quite hardy. Berry, very large, rounded, purple, downy, firm, juicy, acid, of harsh taste; quality, good; grain, very large; seeds, large. Its season is the same as that of the Cuthbert. It has been very productive and the fruit is of fine appearance, but it is not pleasant to most tastes. It would be recommended for the sake of variety.

Stayman's No. 5.—Plant, of rather small growth, comparatively free from disease. Berry, medium size, purple; grain, of medium size; seed, very large and hard, Season, 4 to 5 days after Cuthbert, making it one of the latest of the red raspberries. It has been so far a very shy bearer, but may improve with age.

Turner.—The plant is one of the strongest growers of the red raspberries and more free than any other from disease. Cane, 3½ to 4½ feet high, naturally branching where thin, but where crowded growing up unbranched and slender, hardy. Fruit, where plants are not too much crowded, is very large, soft, juicy, sweet or subacid, very pleasant to the taste, though not of high quality; grain and seed, small. This is one of the early varieties, its season being a week to ten days earlier than Cuthbert, and it is also one of the most productive. It is too soft to be of value for shipping and soon becomes unsalable even for home market unless very carefully handled.

CONCLUSIONS.

There are quite a number of the newer varieties, both of blackberries and raspberries, that we have not yet tested and among them there may be something of more value for some purposes than those here described. The standard varieties are standard, because they have successfully stood a long test over a wide range of country, and so one can make no mistake in planting them.

Of the blackberries which we have grown, Snyder still takes the lead. Minnewaska would rank second. It is not so good in quality as the Snyder but it is as productive and does not seem so liable to injury from drouth. For an early variety Early king is hardier than Early harvest.

Of black raspberries the Kansas, a new variety, seems to stand at the head, next would come Gregg or Nemaha, and Palmer.

Of the red raspberries there is some question. Turner is one of the most productive, is hardy and healthy. The fruit has a mild, very pleasant taste, but it is too soft for a good market variety. The Cuthbert is healthy and nearly as hardy, the fruit larger and firmer, but for home use the taste is rather harsh. Philadelphia is very productive, healthy and hardy, the fruit smaller than that of the other two and too liable to shatter in picking.

Experiment No. 52. Raspberries, Management.

In the spring of 1889 an experiment was started to determine something of the effects of cultivation on the productiveness of black raspberries. For this purpose a plat of Greggs (eight rows sixteen rods long) was taken. These had been planted about 1882, and up to that time had received only ordinary cultivation. Early in the spring of 1889 the four rows on one side of the plat were set apart to be kept thoroughly cultivated from the time the ground was in good condition until the latter part of August, when the work would stop for the sake of putting down the tips. The other four rows were to be allowed to go until after the fruiting season, only having the weeds mowed off in the meantime, then to be thoroughly cultivated until the end of the season. This gave an average of about 4½ months cultivation for the first four rows and 1½ months cultivation for the others. This scheme has been carried out with practical uniformity since.

No account had been taken of the comparative yields of the separate rows up to this time, but there had appeared to be very little difference. The yields for the season of 1889 were, for the four rows cultivated during the whole season, 287 quarts, and for those cultivated only during the latter part, 262 quarts. After the fruit was gone the old wood was at once taken out. By the time the year's growth was completed there was apparently little difference between the rows cultivated all the season and those cultivated the latter part only, and after the spring pruning had been done, no difference could be noticed.

The crop in the summer of 1890 was, for the four rows cultivated all the season, 358 quarts, and for the others, 274 quarts. At the close of the season there was more difference in favor of the well cultivated rows than had been seen the previous year, and some difference could be seen after the spring pruning.

The crop for the season of 1891 was, for the four rows cultivated all the time, 487½ quarts, and for the other four rows, 272½ quarts, the difference in actual yield being very much more than the apparent difference during the fruiting season. Up to this year there had been no apparent difference in the size and development of the berries, but during this season the fruit on the well tended rows was much finer than on the others.

The respective crops of the four rows cultivated all the season, and the other four for the summer of 1892, were 448 and 244 quarts.

During the summer of 1892 the new canes did not make so good a growth as they had in previous years, and unfavorable conditions later destroyed many of the plants; those in the four rows receiving the most attention, being damaged the worst. As a consequence the results, though not contradicting those of previous years, would not help them out. The yields were for the four rows cultivated all the season, 119 quarts, and for the others, 117 quarts.

As a total result of this line of work so far, there would be the following:

	Four rows kept cultivated from early spring until fall.	Four rows cultivated from the time the fruit was off until fall
1889	287	262
1890	358	274
1891	487½	272½
1892	448	244
1893	119	117
Total	1699½	1169½

This experiment has so far been made to include only the black raspberry; and as it has been conducted shows only the difference between a full season's culture and culture the latter part of the season. It is probably safe to say that the rows receiving the least attention had more cultivation and better than the average of the berries grown in this locality. As a result of the test it is at least safe to draw the conclusion that it would be profitable to give the black raspberry much better care than it gets.

There is always more or less discussion as to whether or not it is best to take out the fruiting wood from a field of raspberries or blackberries as soon as the crop is off. Our practice heretofore has been to take out the old wood at once when the last picking was done. The reasons were that as we must hire the work done, it was as cheap doing it one time as another, and the clearing out improved the appearance. It was supposed also that the old canes would be a detriment rather than an advantage to the new ones, on account of crowding, which would not allow the plants to develop fully, and it was also supposed that there was no value in the old wood after the fruit was off.

As a preliminary test of this point, a single row 16 rods long was in 1892 left with the old wood in, while corresponding rows on each side that appeared equally good, were cleaned out in the usual manner. As a result of the one trial there is one row in which the old wood was left until spring (March), yielding 73 quarts, and two rows, one on each side of the preceding, from which the old wood was taken as soon as the fruit was off the previous year, yielding 41 and 48 quarts, respectively.

While this one test is not conclusive, it points to the probability that it may be better to leave in the old wood until the regular spring pruning than to take it out as soon as the fruit is gone. It might at least pay the raspberry grower to try to see if the old, but yet living canes are of value to the new growth.

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All communications intended for the Station should be addressed, not to any person, but to the

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The bulletins of the Experiment Station will be sent free of all charges to persons engaged in farming who may request that they be sent.

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Agricultural Experiment Station.

CHAMPAIGN, MARCH, 1894.

BULLETIN NO. 31.

CORN AND OATS EXPERIMENTS, 1893.

EXPERIMENTS WITH CORN.

This bulletin gives the results of some experiments with field corn in 1893, together with the summary of the results obtained in the same experiments in 1888, 1889, 1890, 1891, and 1892.

The following are reported:

No. 1. Test of varieties.
No. 3. Time of planting.
No. 4. Depth of planting.
No. 5. Thickness of planting.
No. 6. Planting in hills or drills.
No. 8. Frequency of cultivation.
No. 9. Depth of cultivation.
No. 10. Effect of root-pruning.
No. 23. Continuous cropping with corn contrasted with rotation of crops.
No. 71. Corn fodder, effect of ripeness.
No. 89. Cross fertilization.
No. 90. Growth of the corn plant; increase of its dry matter.

SUMMARY.

The experiments were tried on the dark colored, fertile, prairie soil common to central Illinois. The surface soil is about 18 inches deep, underlaid with yellow clay. The land on which the tests of varieties were conducted had been in corn in 1892. It was plowed in the spring, no fertilizers being applied. The land used for most of the other experiments had been in clover in 1892, and was plowed in the spring after a liberal application of stable manure. The corn was planted by hand and covered with the hoe, the rows being 3 ft. 8 in. apart, and the hills, generally, the same distance apart in the rows.

The season was characterized by extreme drought during the summer months. The rainfall for the five months from May to Sept., inclusive, was 10.65 in.; but that from June 11th to Sept. 11th was only .94 of an inch. The mean temperature for the five months and for each month was not materially different from the average for the past five years. The yields of corn and of stover were less in all the experiments, as well as in the other field crops on the University farm, than in any year since 1887. The exceptional character of the season reduces the value of the results obtained in most of the experiments. This is believed to be especially true of the results in the tests of varieties. But the conclusions reached from a comparison of the results of experiments tried for six successive years are probably the more valuable because they include this unusually unfavorable year.

The results of the experiments for the six years, from 1888 to 1893, well illustrate the fact that the soil and climate of central Illinois is admirably adapted to the production of Indian corn. Eleven different varieties have been cultivated in each of these six years without exceptionally good care or treatment of any kind, and without the application of other than stable manure. The average yield of air-dry corn of these eleven varieties has been almost 63 bu. per acre.

The division of varieties into early, medium, and late maturing is necessarily somewhat arbitrarily made. The average yield of all early varieties has been 54, of medium, 65, and of late maturing, 59 bu. per acre. The largest average yield of any one variety for the six years has been slightly under 70 bu. per acre.

The average yield of air-dry stover for five years, from the medium maturing variety, Burr's white, when planted in rows 3 ft. 8 in. apart, is 4.5, 3.5, 3, and 2.8 tons per acre, when planted at the rate of one kernel every 3, 6, 9, 12, and 15 in., respectively. As corn is ordinarily planted, 3 tons per acre is a good yield of stover.

The tests at the Station indicate the advisability of the selection of medium rather than either early or late maturing varieties; those with ears above the average, but not remarkably large in size, and those which combine as many good qualities as possible. But some of the most profitable varieties have been faulty in some respects. The largest yields of shelled corn have not been secured from varieties with the smallest cobs, or with deepest kernels, or, in all cases, with symmetrical ears. As a rule, it is not advisable to select for the main crop a variety which has been produced far north or south of the latitude in which it is to be planted. A small acreage of some early maturing variety may be profitably planted for use in the early autumn. Such varieties are also valuable if corn must be planted exceptionally late.

No one variety has been shown to be greatly superior to all others. There are many varieties much resembling each other. It has not been shown that the yield depends upon either the color of the kernel, or on the exact shape of either the ear, or the kernel. Large numbers of excellent varieties have been obtained from different sources, often when they have had little more than a neighborhood reputation. The claims made for many varieties advertised by seedsmen have not been sustained. In many cases there seems little reason for Illinois farmers to send out of their own county for seed corn. Corn obtained from different sources under the same name often differs materially. Corn obtained with differing names is often much alike.

The results of experiments with cross-bred corn suggest the importance of thorough trials of the practice of crossing desirable varieties. Uniformity of type is sacrificed, but in a large majority of the trials made at the Station the yields from cross-bred seed have been larger than those from the pure bred parent seed.

Contrary to the opinion and practice of the large majority of Illinois farmers, the results of the experiments as to thickness of planting, almost without exception, indicate that thicker planting than is ordinarily practiced will give larger yields of both corn and stalks. In five years out of six, planting at the rate of at least 12,000 kernels per acre, which is equivalent to 4 kernels per hill in the rows at the usual distances for planting in Illinois, has given larger yields of corn than thinner plantings. In the exceptionally dry year, 1893, somewhat thinner planting gave better results. The thicker planting produces smaller ears, and reduces the average weight of the stalks. The result of all trials at the Station clearly indicates that in average seasons, in central Illinois at least, a lessened yield may be expected if the number of stalks is less than 3 a hill.

In no year out of the six was any material difference shown in the yield of corn, whether planted in hills or drills, where an equal number of kernels was planted, and the ground kept equally free from weeds.

The date of planting, within reasonable limits, has not materially affected the yield. The largest average yields have been secured by planting from May 10th to 15th, with no material variation in yield, if the planting was done at any time from May 1st to 25th. If the ground was in equally good condition at the time of planting, less cultivation has usually been necessary for the later than for the earlier plantings.

Uniformly shallow covering has been found somewhat better than deep covering; but it is probable that the corn is more carefully, covered by the use of the hoe than it is where machines are used.

Shallow cultivation has uniformly given better results than has deep. Purposed root-pruning has in all cases decreased the yield. It has not been proved that comparatively deep culture, while the corn is small, would be injurious. Unusually frequent cultivation has in some cases decreased the yield, and in no case been profitable. No one implement has been shown to be clearly superior to all others. It is believed the best results can be secured with the smallest expenditure of time and labor by having the ground in good condition at the time of planting beginning cultivation before grass or weeds have made much growth, and stirring the entire surface of the soil as nearly as practicable to the depth of not more than 2 or 3 in., often enough to keep the surface well pulverized and to prevent the growth of weeds and grass. Each year yields of corn not much below the average have been secured without any cultivation subsequent to planting, except scraping the surface with a sharp hoe to prevent the growth of weeds. On soils of different texture other methods of cultivation may be better.

Repeated observations show that the percentage of dry matter in the corn plant, both stalk and ear, increases up to the time of maturing. It has not been shown that the digestibility is decreased as maturity increases. In many cases the palatability of both stalk and ear does decrease. Leaving the stalks uncut until they reach full maturity increases probability of loss from storms, and often makes it necessary to harvest the crop in less favorable weather. It seems clearly proved, however, that there often has been a considerable loss in the total food value of the crop by cutting it at too early a stage, whether designed for ensilage or for dry fodder. The percentage of water in the young corn plant is surprisingly large, while the quantity of dry matter and the food value is very much less than that found as the plant approaches full maturity.

CHARACTERISTICS OF THE SEASON.

The year 1893 was exceptionally unfavorable for corn in Illinois, especially in the central eastern portion. The rainfall was above the average in April and May, but was almost unprecedentedly light for a period of three months beginning June 11th. As stated before, from this date to September 11th, the total rainfall at the Station was only .94 of an inch. The temperature during all the growing season was somewhat below the average, but in no month noticeably different from it. The unusual drought greatly interfered with the growth of the corn and reduced the yields in all cases, both of grain and of stover. The later varieties were more seriously affected than those ripening earlier. Varieties which in former years gave remarkably large yields, but which usually did not mature sufficiently early to be counted desirable for central Illinois, in 1893 were almost total failures so far as the yield of grain was concerned. In one case there was 69 per cent of the stalks without any ears. Most of the varieties ordinarily classed as late ripened at such a date as to be classed with the medium, and some varieties, usually classed as medium, had to be put with the early maturing varieties.

In view of these unfavorable conditions much less importance should be attached to the varying yields of different varieties than to their average yields for the series of years during which they have been tested by the Station.

The table gives the mean temperature and the rainfall in inches from May to September, inclusive, for each year from 1887 to 1893.

The records for 1887 and 1888 are those of the Illinois Weather Service for central Illinois. For the remaining years the records are those of the observations made at the Station.

TEMPERATURE AND RAINFALL DURING THE CORN SEASON OF YEARS NAMED.

	Mean temperature, F.					
Year................	May.	June.	July.	August.	Sept.	Average.
1887.................	67.9°	73.6°	80.4°	75.2°	66.4°	72.7°
1888.................	59.4°	71.3°	77°	72.4°	62.4°	68.5°
1889.................	59.2°	65.5°	72.7°	69.2°	61.3°	65.6°
1890.................	58.3°	74.6°	73°	68.7°	60.5°	67°
1891.................	58.4°	72°	70°	70.2°	69.2°	68°
1892.................	57.9°	70.6°	73.3°	71.5°	63.9°	67.4°
1893.................	57.4°	70.5°	76.4°	71.1°	66.5°	68.4°
Average, 1889–93......	58.2°	70.6°	73.1°	70.1°	64.3°	67.3°
	Rainfall, inches.					Aggregate
1887.................	3.84	1.62	1.65	2.56	3.68	13.35
1888.................	6.84	5.75	5.34	3.14	1.95	23.02
1889.................	5.52	6.81	5.84	.6	2.74	21.51
1890.................	3.56	3.8	2.83	1.93	1.19	13.31
1891.................	.89	2.08	1.41	2.86	.41	7.65
1892.................	7.86	5.36	2.5	2.43	.93	19.08
1893.................	4.83	1.55	.59	.06	3.62	10.65
Average, 1889–93......	4.53	3.92	2.63	1.57	1.78	14.44

Experiment No. 1. Corn, Testing Varieties.

Tests of varieties of dent corn have been made for seven consecutive years, reports of which may be found in bulletins No. 4, 8, 13, 20, and 25.

The land used in 1893 was the same as that used for this experiment the preceding year. The stalks were removed, the land plowed about five inches deep, harrowed twice, and marked a few days before planting. The corn was planted by hand, six kernels a hill, in checks 3 ft. 8 in. apart, and was covered about two inches deep with a hoe.

The planting was done May 19th to 23d. The plats, 119 in number, each one-fortieth of an acre, 2 rods or 9 hills square, were so planted that corn grew on every side. June 9th to 24th the corn was cultivated three times with surface cultivators, the first time with the "Superior" and the second and third times with the "Tower." July 18th to 24th the remaining weeds were removed with a hoe. Soon after the first cultivation the corn was thinned to four plants a hill. Plats 31, 87, 89, 90, 93, and 100 failed and were again planted, this time with Murdock, but no account is made of them in what follows. The number of barren stalks and the average height to tips of tassels and butts of ears were ascertained for each plat. Observations were made on the time of ripening. October 7th to 13th the plats were husked by thirds and the weight and number of ears ascertained for each third. The middle third was at once shelled, the number and weight of both good ears and nubbins, and the weight of both shelled corn and cobs, being ascertained. A pint jar of shelled corn from each plat was sent to the laboratory for the determination of water. Eleven per cent is taken as the average water content of air-dry corn.

Duplicate Plats.

While the attempt was to have uniform soil and like treatment throughout, the differences in yield, as in former years, of plats planted with the same variety were considerable. There were four plats each of Leaming and Murdock, and two plats each of fourteen other varieties, as shown in the table. The greatest difference in yield per acre between two plats of the same variety was with Murdock, 15 bu.; Leaming, 13.8 bu.; the average difference, Murdock, 8.2 bu.; Leaming, 7.5 bu.; and the least difference, Murdock, 4.2 bu.; Leaming, 1 bu.

These differences, though considerable, are somewhat less than those found between different varieties of even the same class. For example, the greatest difference between two plats of the 49 planted with early maturing varieties was 26.9 bu. an acre, and of the 49 medium maturing, 29.4 bu.

Yield per Acre of Air-dry Corn upon Duplicate Plats, 1893.

Variety.	a	b	c	d	Average.
Murdock	43.4	33.5	37.7	28.4	35.7
Leaming	30.7	29.7	43.5	34.5	34.6
Edmonds	24.7	32.9	......	......	28.3
Dunlap's white	28.4	28.1	......	......	28.2
Steward's improved	29.7	36.2	......	......	33
Riley's favorite	38.6	37.6	......	......	38.1
Boone county white	32.9	34.6	......	......	33.8
Burr's white	35.2	42	......	......	38.6
Hess white	40.8	29.5	......	......	35.2
Hughes	31.6	37.1	......	......	34.4
Clark's Onarga	37.7	34.3	......	......	36
Thomas	31.5	29.2	......	......	30.4
Log cabin	22.7	31.8	......	......	27.3
Bickerdike's early mammoth	21.1	29	......	......	25.1
Helms improved	11.6	20.4	......	......	16
Yellow [no name]	30.6	30	......	......	30.3

When the variation of yield of different varieties does not exceed that of different plats of the same variety the results are inconclusive. A greater variation may properly be attributed, in part at least, to the variety. If single plats are used, it is only after varieties have been tested for a series of years that we can conclude which are the most prolific; but other things can be ascertained in a single year, such as time of maturity, size, ratio of ears to stalks, ratio of shelled corn to cobs, and the general characteristics of stalk and ear. If several plats, widely distributed over the tract, are used for each variety and the average yields ascertained, these form a better basis for a comparison of the varieties in respect to yield; for in this way the effect of differences in the conditions of the test is much diminished.

MIXTURES.

Four plats were planted, each with equal parts of two varieties of corn, and one with equal parts of four varieties. The accompanying table gives the number of ears and bushels an acre for each variety planted separately, and their average as compared with the result of the mixture. In four out of the five cases the mixtures gave larger yields than the average of the varieties composing them. This is contrary to the results of 1892, when in four out of five cases the yields were smaller for the mixtures. In 1892, the average difference in yield was 3.7 bu. an acre in favor of the varieties grown separately; in 1893, 2.4 bu. in favor of the mixtures.

RESULTS OF MIXTURES, 1893.

Plat No.	Name of Variety.	Yield per acre.	
		No. of ears.	Bu. air-dry corn.
45 & 110	Hughes	8520	34.3
63 & 111	Thomas	7620	30.4
	Average	8700	32.3
101	Mixture of Hughes and Thomas	9000	20.5
13 & 115	Burr's white	10200	38.6
12 & 114	Boone county white	8690	33.8
	Average	9445	36.2
102	Mixture	8760	36.7
57 & 97	Riley's favorite	6300	38.1
34 & 107	Bickerdike's early mammoth	8280	25.1
11 & 106	Hess white	9660	35.2
10 & 86	Dunlap's white	7980	28.2
	Average	8055	31.6
103	Mixture	9600	37.5
	Murdock (average of 4 plats)	9600	35.7
58 & 98	Edmonds	7740	28.3
	Average	8670	32
104	Mixture	9120	37.3
	Leaming (average of 4 plats)	8070	34.6
56 & 96	Clark's Onarga	9240	36
	Average	8655	35.3
105	Mixture	9360	47.3

CLASSIFICATION OF VARIETIES.

The table on page 340 gives a classification of the varieties tested this year, and the yield of air-dry corn by each variety. It is based upon the time of ripening, color, and smoothness or roughness of the outer end of the kernels. Varieties maturing before Sept. 13th are classed as early; those maturing Sept. 13th to Sept. 30th, as medium; and those maturing after Oct. 1st, as late. The varieties that are very near the

SYNOPSIS OF VARIETIES, 1893.

Corn .	Early . .	Yellow .	Smooth .	Leaming (av. 4 plats)	33.3	30.3
				Star	27.3	
				Woodhull	22	
				Bickerdike's early mammoth	21.1	
				Clarage	22.1	
				Yellow (no name)	22.3	
				Munns	30.3	
				Clark's Iroquois	30.7	
				B. O. E. ensilage	40	
				Queen of the field	33.4	
				Thomas corn	31.5	
				Minnesota king	26.8	
				Early Huron	37.6	
				Early Butler	35.5	
				Cuban queen	40.4	
			Rough . .	Murdock (av. 4 plats)	35.7	28.9
				Chester county mammoth	17.3	
				Log cabin	22.7	
				Eclipse	16.1	
				Yellow (no name)	34.5	
				Edmonds (av. 2 plats)	28.8	
				Legal tender	33.8	
				Pride of the north	30.1	
				Yellow (no name)	21.8	
				Pride of Columbia	34.6	
				King of the earlies	31.7	
				Wisconsin yellow	33.9	
				Leaming	34.5	
		White . .	Smooth .	White (no name)	19.5	31
				Champion white pearl	42	
				White (no name)	30.4	
				Mills county white	33.2	
				White (no name)	35.2	
				Baker's white	26	
			Rough . .	Ohio white dent	26.8	31.7
				Dunlap's white (av. 2 plats)	28.2	
				Ivory dent	28.9	
				Wisconsin white	34.9	
				Van's early	31.6	
				White (no name)	39.2	
				Callaway's white	32	
			Smooth .	Pride of Kansas	35.5	30.5
				Golden beauty	36.4	
				Fisk's yellow	19.5	
				Yellow (no name)	27.1	
				Hughes (av. 2 plats)	34.3	
				Leaming	31.8	
				Sterling	22	
				Clark's Onarga (av. 2 plats)	36	
				90-day	30.2	
				Arleus	33.2	
				Branson's climax	40.8	
				Nims prolific	31.8	
				Waterloo extra early	30.8	
				Early golden	19.3	
				Golden dent	30.6	
				Bickerdike's early mammoth	29	
				Log cabin	31.8	
				Thomas corn	29.2	

Medium	Yellow	Rough	Piasa queen	16	29.1
			Farmers' interest	29	
			Prentice corn	24.2	
			Champaign county prolific	22	
			Early mastodon	28.3	
			Cloud's early	30.5	
			Baker's yellow	26	
			California yellow	30.4	
			Yellow (no name) (av. 2 plats)	30.3	
			Steward's improved (av. 2 plats)	32.9	
			Riley's favorite (av. 2 plats)	38.1	
			Little boss	25.5	
			Leaming	43.5	
	Mixed	Rough	Blue River	45.2	
	White	Smooth	Hess white (av. 2 plats)	35.1	
		Rough	Piasa king	23.6	32
			Fisk's white	41.2	
			Boone Co. white (av. 2 plats)	33.7	
			Burr's white (av. 2 plats)	38.6	
			White beauty	34.8	
			Champion white pearl	37.3	
			Clark's favorite	15.8	
			Short stalk	31.1	
Late	White	Smooth	Helms improved (av. 2 plats)	16	

dividing lines as to time of maturity and smoothness or roughness, are subject from year to year to change from one class to another, hence we see that the classification for 1893 differs considerably from that of former years. The fact that so many varieties which have heretofore been classed as medium, fall this year into the early class, can be accounted for by the dryness of the season.

RESULTS.

The number of plats in each of the three classes, early, medium and late, and the results for each class for each of six years, are shown in the table on page 343. In each of the years 1888 to 1892, inclusive, there has been an average of from four-fifths to seven-eights of a full stand, reckoning four stalks in each hill as a full stand. In 1893, however, the stand was more nearly perfect, it being over 93 per cent. The better stand was due to the fact that the corn was planted thicker than usual, and afterward thinned to four plants a hill.

For 1888, 1890, 1891, and 1892 the per cent of barren stalks was comparatively uniform, averaging about eleven; while in 1889 it dropped to about 1.5 per cent, and in 1893 went up to 22, 23, and 50 per cent for the three classes, early, medium, and late, respectively. Only one variety was classed as late, and it has made some very good yields in former years. The noticeable barrenness in 1893, is probably due, chiefly, to the severe drought and the fact that the corn was planted thicker than formerly.

Though varying much from year to year, owing to the nature of the season, in general the height of both stalks and ears increased with lateness of maturity, as did also the length and circumference of ears.

In general the weight of 100 ears has increased, and the number of ears per acre decreased with the lateness of maturing. The pounds of ear corn, as weighed when husked, which must be taken to make a bushel of air-dry shelled corn, invariably increase with the lateness of maturity. This is due largely to the fact that the per cent of water is greater in the late maturing varieties when husked.

Each year, excepting 1892, the medium maturing varieties have made the largest average yields; the average of air-dry shelled corn for the six years being as follows: Medium, 65.3 bu.; late, 59.5 bu.; and early, 54.4 bu. per acre.

The following table gives the yield for each of eight varieties for seven years, and of eleven for six years, arranged in the order of the average yields. Of these varieties, champion white pearl, Burr's white, and Helms improved, are white; the others are yellow. Murdock and Edmonds are early maturing, Helms improved, late, and the others, medium. The average yield of the eleven varieties for six years is 62.9 bu. per acre. Other varieties of considerable merit, that have been tested for three or more years, are Dunlap's white, Clark's Onarga, California yellow, and ivory dent.

YIELD OF AIR-DRY CORN OF VARIETIES TESTED FOR YEARS NAMED.

Eight varieties tested in	1887.	1888.	1889.	1890.	1891.	1892.	1893.	Av.
Leaming	29.6	86.6	80.6	69.4	67.3	70.1	34.6	62.6
Champion white pearl	20.2	70	94.8	74.9	76.5	65	37.3	62.4
Burr's white	30	85.9	75.7	67.7	67.7	64.2	38.6	61.4
Steward's improved yellow	32.4	91.2	68.7	54.7	58.4	74.4	33	59
Riley's favorite	30.8	81.8	66.1	53.3	56.1	74.1	38.1	57.2
Murdock	33.3	80.3	65	61.6	59.8	57.6	35.7	56.2
Legal tender	25.8	84.2	68.9	60	56.8	60.3	33.8	55.7
Edmonds	27.7	83.7	66.3	55.9	58.6	58.4	28.3	54.1

Eleven varieties tested in	1888.	1889.	1890.	1891.	1892.	1893.	Av.
Champion white pearl	70	94.8	74.9	76.5	65	37.3	69.7
Leaming	86.6	80.6	69.4	67.3	70.1	34.6	68.1
Burr's white	85.9	75.7	67.7	67.7	64.2	38.6	66.6
Steward's improved yellow	91.2	68.7	54.7	58.4	74.4	33	63.4
Clark's Iroquois	68.5	81.9	59	65.4	72.9	30.7	63.1
Riley's favorite	83.7	66.3	55.9	58.6	74.1	38.1	62.8
Helms improved	84.8	102.6	51.1	39	79.2	16	62.1
Fisk's yellow	76.6	79.5	61.7	57.4	60.1	19.5	59.1
Legal tender	84.2	68.7	60	56.8	60.3	33.8	60.6
Murdock	80.3	65	61.6	59.8	57.6	35.7	60
Edmonds	81.1	66.1	53.3	56.1	58.4	28.3	57.2

A comparison of the white and yellow varieties for 1893, shows an average yield of 30.5 bu. an acre for the white and 30.4 bu. for the yellow. A comparison of the rough and smooth ones, gives an average yield of 30.6 bu. an acre for the rough and 30.3 bu. for the smooth. The average yield per acre for six years is 61.6 bu. for the white, and 60.4 bu. for the yellow.

SUMMARY OF RESULTS WITH THE THREE CLASSES—EARLY, MEDIUM, AND LATE MATURING—FOR EACH OF SIX YEARS.

	Per cent.				Average.					Number good ears per acre.	Number nubbins per acre.	Total number ears per acre.	Weight, lb.			Lb. ears.		Yield per acre, bu.				Loss per acre in drying, bu.	Per cent water in corn as husked.
	Kernels germinating in apparatus.	Kernels germinating in field.	Of full stand.	Of barren stalks.	Height stalks, ft.	Height butt of ear, feet.	Length 3 specimen ears, in.	Circum. 3 specimen ears, in.	Circum. 3 specimen cobs, in.				100 good ears.	100 nubbins.	100 average ears.	As husked per bu.	As husked per bu. air-dry.	From good ears.	From nubbins.	Total, as husked.	Total air-dry.		
Av. of Plats, 1888—																							
27 early	96	84	88	8	9.8	4.5	8.3	6.3	3.7	7597	2948	10545	60	35	53	67.2	73.3	67.5	15.1	82.6	75.6	7	18.3
32 medium	97	80	87	11	11.5	5.5	9	7	4	7482	2741	10223	74	33	68	68.4	78.1	84	18	102	89.8	12.2	21.8
15 late	90	74	85	13	12.2	6.2	9.7	7.2	4.2	6263	2745	9008	93	51	80	71.4	87.8	81.2	20.4	101.6	83.2	18.4	27.2
Av. of plats, 1889—																							
3 early	93	70	84	1.7	6.9	2.8	7.4	6.2	3.4	6520	3360	9880	46	26	39	66.1	70.6	45.8	13.5	59.3	55.6	3.7	16.6
42 medium	97	68	80	1.2	8.9	4.2	8.1	6.4	3.9	6695	3535	10230	72	40	61	69.6	81.1	68.8	19.7	88.5	75.4	13.1	23.8
22 late	96	65	78	.5	9.9	4.7	9.6	7.2	4.3	6055	3840	9895	81	43	67	72	90.2	70	22.2	92.2	73.5	18.7	28.8
Av. of plats, 1890—																							
14 early	96	81	79	10	8.1	3.5	8.1	6.4	3.7	5374	3610	8984	55	28	44	66.2	70.4	44.5	14.8	59.3	55.6	3.7	16.5
29 medium	94	86	83	12	9.6	4.5	8.3	6.6	3.8	5292	3749	9041	61.3	31.9	50	67.2	73.3	50	17.7	67.7	62	5.7	18.4
8 late	93	81	79	13	10.1	5.2	8.4	6.2	3.3	4651	3806	8457	60.1	34.1	48.7	67.1	78	47.1	18.5	65.6	56.6	9	23.2
Av. of plats, 1891—																							
13 early	....	87	86.1	10.4	6.8	3.4	7.6	6.2	3.7	5464	4088	9552	49.6	28.5	40.2	*66.3	72	....	....	*58.2	56.1	....	*14.3
19 medium	....	88.4	86.4	12.6	7.7	4.2	8	6.6	3.9	6334	3400	9734	58.6	31.6	48.8	*69.3	75.8	....	....	*69.9	66.1	....	*15.9
6 late	....	87	84	14.8	8.6	4.3	7.5	6.2	3.9	5112	3400	8513	61.3	33	49.8	*67.7	86.8	....	....	*63.9	57.4	....	*20.3
Av. of plats, 1892—																							
16 early	96	91	81	8	8.1	3.7	7.7	6.1	3.5	5242	4681	9922	53	25	41	68.1	77.4	....	....	60	52.8	7.2	21.6
67 medium	89	87	82	9	8.8	4.3	8.4	6.6	3.9	5438	4473	9858	66	35	53	68.4	76.6	....	....	75.8	68	7.8	20.5
9 late	93	85	80	10	10.2	5.4	8.8	7	4	5011	4064	9075	81	47	69	71	89.9	....	....	88.1	70.2	17.9	29.3
Av. of plats, 1893—																							
49 early	96	....	94	22	7.3	3.3	....	....	....	2258	6448	8706	48	24	30	71.4	84	....	....	35.8	30.7	5.1	23.7
49 medium	95	....	92	23	7.7	3.6	....	....	....	2385	5542	7927	55	27	35	73.7	91.9	....	....	39.1	31.5	7.6	28.4
2 late	96	....	98	50	8	4.3	....	....	....	1320	3060	4380	49	25	33	77	108.8	....	....	22.6	16	6.6	37.2

*When shelled.

VARIETY OF CORN; SOURCE OF SEED; GERMINATION; STAND; BARREN STALKS; HEIGHT OF STALKS AND EARS, 1893.

Plat.	Name of Variety.	Seed received from,		Per cent germinat'g in Geneva apparatus.	Per cent of full stand of stalks.	Per cent of barren stalks.	Date of ripening.	Height, ft.	
								Stalks.	Ears.
1	Leaming	University farm		96	89	16	Sep. 13	8.3	3.9
2	Helms improved	Fred Helms	Belleville, Ill.	96	102	69	Oct. 5	8.1	4.4
3	Piasa queen	E. P. Kellenberger	Godfrey, Ill	100	107	54	Sep. 25	8.3	4
4	Piasa king	" "	" "	92	98	41	" 25	8.7	4.4
5	Murdock	University farm		100	91	17	" 13	7.7	3.5
6	Blue River	J. Percival	Champaign, Ill	100	86	10	" 25	8.2	4.5
7	Fisk's white	E. C. Fisk	Havana, Ill	98	91	21	" 25	8.5	3.9
8	Ohio white dent	M. H. Smith & Son	De Soto, Neb	84	90	28	" 13	7.7	4.2
9	White variety (no name)	William Sieck, Jr.	Greenville, Ill.	100	105	26	" 13	7.2	3.4
10	Dunlap's white	H. M. Dunlap	Savoy, Ill	96	93	28	" 13	7.3	3.3
11	Hess white	Agricultural Experimental Station	Columbus, Ohio	92	89	19	" 25	7.7	3.7
12	Boone county white	James Riley	Thorntown, Ind	98	90	22	" 25	7.8	3.4
13	Burr's white	University farm		88	94	25	" 25	7.4	3.4
14	Champion white pearl	E. P. Kellenberger	Godfrey, Ill	100	105	14	" 13	7.8	3.7
15	Ivory dent	R. H. Vanderhoof	Newton, Ill	98	90	22	" 13	7.5	3.6
16	White corn (no name)	J. C. Sweet	Fairbury, Ill	....	94	30	" 13	7.3	3.5
17	White beauty	R. H. Vanderhoof	Newton, Ill	98	92	15	" 25	8.4	4.3
18	Mills county white	Nims Bros	Emerson, Iowa	96	87	22	" 13	7.6	3.3
19	White corn	John Ramseyer	Congerville, Ill	96	96	24	" 13	6.7	2.8
20	Champion white pearl	W. W. Barnard	Chicago	....	82	25	" 25	7.6	3.2
21	Farmers' interest	Geo. T. Leatherman	Burlington, W. Va	100	93	31	" 25	6.9	3.2
22	Star corn	S. P. Campbell	Loami, Ill	100	85	29	" 13	7.7	3.7
23	Prentice corn	Geo. Prentice	Hallock, Ill	98	88	34	" 25	6.6	3.1
24	Woodhull	Samuel Wilson	Mechanicsville, Pa	98	95	44	" 13	7.2	3
25	Pride of Kansas	" "	" "	94	105	19	" 25	7.7	3.6
26	Chester county mammoth	J. C. Vaughan	Chicago	92	93	51	" 13	7.7	3.6
27	Champaign county prolific	" "	"	100	100	38	" 25	7.2	3.3

28	Early mastodon	Currie Bros	Milwaukee	76	63	22	Sep. 25	7	2.9
29	Golden beauty	W. W. Barnard	Chicago	....	74	19	" 25	8.1	3.8
30	Cloud's early	Henry A. Dreer	Philadelphia	78	85	23	" 25	7.6	2.7
32	Log cabin	C. N. Butt	Knoxville, Ill	100	98	34	" 13	7.7	3.6
33	Fisk's yellow	E. C. Fisk	Havana, Ill	96	94	39	" 25	6.6	3.1
34	Bickerdike's early mammoth	James Bickerdike	Griggsville, Ill	96	104	38	" 13	7	3.2
35	Clark's favorite	James B. Martin	Atwood, Ill	....	104	28	" 25	7.1	3.2
36	Clarage	Agricultural Experiment Station	Columbus, Ohio	....	96	33	" 13	7.6	3.6
37	Eclipse	E. P. Kellenberger	Godfrey, Ill	100	108	49	" 13	7.8	3.9
38	Yellow (no name)	J. A. Foote	Terre Haute, Ind	....	95	35	" 13	7.4	3.7
39	Baker's yellow	G. W. L. Baker	Payson, Ill	100	101	30	" 25	7.9	4.2
40	California yellow	J, C. Vaughan	Chicago	96	97	15	" 25	8.1	3.8
41	Yellow (no name)	B. S. Tyler	Decatur, Ill	92	86	35	" 25	8.1	3.9
42	Yellow (no name)	W. C. Gibbs	Winchester, Ill	100	98	23	" 25	7.7	3.6
43	Munns	Jas. Riley	Thorntown, Ind	94	80	29	" 13	8	3.4
44	Yellow (no name)	Thomas Stephens	Sadorus, Ill	88	96	20	" 13	7.3	3.5
45	Hughes	Agricultural Experiment Station	Columbus, Ohio	....	99	21	" 25	7.8	4.1
46	Steward's improved	L. W. Steward	Amanda, Ohio	100	96	29	" 25	8.2	4.2
47	Leaming	University farm		96	100	26	" 13	7.9	3.8
48	Clark's Iroquois	H. H. Clark	Onarga, Ill	96	96	24	" 13	6.9	2.9
49	Murdock	University farm		100	97	15	" 13	7.2	3.4
50	Burr Oaks Leaming	J. H. Beagley	Sibley, Ill	94	96	16	" 13	7.6	3.4
51	Short stalks	J. B. Martin	Atwood, Ill	....	98	26	" 25	7.2	3.7
52	B. O. E. Ensilage	J. H. Beagley	Sibley, Ill	92	93	17	" 13	7.6	3.6
53	Leaming	E. P. Kellenberger	Godfrey, Ill	94	101	20	" 25	7.1	3.4
54	Sterling	T. J. Groves	Dana, Ill	96	92	28	" 25	7.3	3.5
55	Improved Leaming	Currie Bros	Milwaukee	98	97	18	" 13	6.9	3.2
56	Clark's Onarga	H. H. Clark	Onarga, Ill	84	93	11	" 25	8	3.8
57	Riley's favorite	James Riley	Thorntown, Ind	100	60	9	" 25	8.3	4.1
58	Edmonds	Fruit & Edmonds	Taylor, Ill	98	95	33	" 13	7.5	3.3
59	Legal tender	Nims Bros	Emerson, Ia	100	103	25	" 13	7.2	3.5
60	90-day	J. W. Babb	Ashland, Ill	98	101	25	" 25	7.3	3.6
61	Queen of the field	J. C. Vaughan	Chicago	100	101	2	" 13	8.2	3.7
62	Arleus	Clement Freeman	Princeton, Ill	92	95	27	" 25	7.7	3.6
63	Thomas corn	Agricultural Experiment Station	Lincoln, Neb	96	92	36	" 13	6.8	3.1
64	Branson's climax	W. T. Branson	Ipava, Ill	98	90	11	" 25	7.8	3.8
65	Pride of the north	J. C. Vaughan	Chicago	68	53	11	" 13	7.1	3.2
66	Steward's improved	L. W. Steward	Amanda, Ohio	100	97	14	" 25	7.2	3.5
67	Nims prolific	Nims Bros	Emerson, Ia	100	92	28	" 25	7.2	3.5

VARIETY OF CORN; SOURCE OF SEED; GERMINATION; STAND; BARREN STALKS; HEIGHT OF STALKS AND EARS, 1893.—Continued.

Plat.	Name of Variety.	Seed received from,		Per cent germinat'g in Geneva apparatus.	Per cent of full stand of stalks.	Per cent of barren stalks.	Date of Ripening.	Height, ft.	
								Stalks.	Ears.
68	Yellow (no name)	E. C. Fisk	Havana, Ill	100	94	15	Sep. 13	6.7	3
69	Pride of Columbia	J. H. Beagley	Sibley, Ill	100	96	16	" 13	7.1	2.9
70	Baker's white	G. W. L. Baker	Payson, Ill	100	92	13	" 13	6.4	2.6
71	Waterloo extra early	Burpee & Co	Philadelphia	....	92	27	" 25	7.5	3.4
72	Minnesota king	N. B. & G. Co	Minneapolis	....	91	15	" 13	6.8	2.6
73	Early Huron	Storrs & Harrison Co	Painesville, Ohio	88	92	11	" 13	6.2	2.8
74	Early Butler	" "	" "	92	91	17	" 13	6.5	2.7
75	King of the earlies	" "	" "	88	98	23	" 13	6.2	2.6
76	Little boss	J. B. Martin	Atwood, Ill	....	104	23	" 25	8.3	4.3
77	Cuban queen	Nims Bros	Emerson, Ia	92	96	15	" 13	6.5	3.2
78	Wisconsin yellow	J. C. Vaughan	Chicago	96	95	16	" 13	6.7	2.5
79	Wisconsin white	" "	"	100	86	7	" 13	7.2	3
80	Van's early	R. H. Vanderhoof	Newton, Ill	98	94	21	" 13	6.2	2.6
81	Early golden	" "	" "	96	96	27	" 25	7.7	3.7
82	Golden dent	" "	" "	100	104	38	" 25	7.5	3.7
83	Murdock	University farm	....	100	98	13	" 13	7.6	3.3
84	White (no name)	G. G. Hunt	Bristol, Ill	....	104	14	" 13	7	3.1
85	Callaway's white	S. H. Callaway	Orion, Ill	92	93	14	" 13	7.3	3.4
86	Dunlap's white	H. M. Dunlap	Savoy, Ill	96	98	18	" 13	7.2	3.3
88	Leaming	University farm	....	96	91	16	" 25	7.5	3.2
91	Helms improved	Fred Helms	Belleville, Ill	96	95	31	Oct. 5	7.9	4.2
92	Champion W. pearl—B. W. cross	Ear No. 35g, 1892	....	....	96	34	Sep. 25	7.9	3.5
94	Leaming—Burr's white cross	" " 6e, 1892	....	....	94	13	" 25	6.7	3.1
95	Edmonds—Murdock cross	" " 16c, 1892	....	....	98	15	" 13	6.8	2.8
96	Clark's Onarga	H. H. Clark	Onarga, Ill,	84	81	22	" 25	8.2	4.1
97	Riley's favorite	James Riley	Thorntown, Ind	100	91	28	" 25	8.3	3.9
98	Edmonds	J. C. Vaughan	Chicago	....	99	14	" 13	7.2	3.5

99	Edmonds-Burr's white cross........	Ear No. 20c, 1892..............	....	....	92	13	Sep. 13	7.5	4
101	Mixture *a*........................	....	....	....	91	24	" 25	6.9	2.9
102	Mixture *b*........................	....	....	....	91	14	" 25	8	3.2
103	Mixture *c*........................	....	....	....	85	13	" 13	7.7	3.6
104	Mixture *d*........................	....	....	....	88	14	" 13	7.7	3.4
105	Mixture *e*........................	....	....	....	93	13	" 25	6	3.8
106	Hess white.........................	Agricultural Experiment Station.	Columbus, Ohio................	92	96	22	" 25	8.2	3.6
107	Bickerdike's early mammoth........	James Bickerdike..............	Griggsville, Ill...............	96	105	20	" 25	8.3	3.8
108	Yellow (no name)..................	W. C. Gibbs....................	Winchester, Ill................	100	70	12	" 25	7.8	4.1
109	Log cabin..........................	C. N. Butt.....................	Knoxville, Ill.................	100	91	8	" 25	7.8	3.1
110	Hughes.............................	Agricultural Experiment Station.	Columbus, Ohio................	....	101	19	" 25	8	3.4
111	Thomas.............................	" " "	Lincoln, Neb..................	96	64	13	" 25	6.9	2.7
112	Leaming............................	University farm...............	....	96	82	21	" 13	8.2	3.8
113	Murdock............................	" "	....	100	94	21	" 13	7.2	3.1
114	Boone county white.................	James Riley....................	Thorntown, Ind................	98	95	18	" 25	7.8	3.7
115	Burr's white.......................	University farm...............	....	88	95	23	" 25	7.2	3.2
116	Self-husking.......................	Currie Bros....................	Milwaukee.....................	100	60	32	" 13	4.9	1.4
117	Golden dew drop...................	Peter Henderson & Co..........	New York......................	90	88	47	" 13	4.6	1.5
118	Brazilian flour.....................	Jno. A. Salzer Seed Co.........	La Crosse, Wis................	....	108	26	Oct. 5	7.2	3.7
119	Longfellow.........................	Henry A. Dreer................	Philadelphia..................	82	65	43	Sep 13	5.2	1.6

NUMBER OF EARS PER ACRE, AND WEIGHT OF 100 EARS, 1893.

Plat.	No. ears per acre.			Wt. 100 ears, lb.			Plat.	No. ears per acre.			Wt. 100 ears, lb.			Plat.	No. ears per acre.			Wt. 100 ears, lb.			Plat.	No. ears per acre.			Wt. 100 ears, lb.		
	Good ears.	Nubbins.	Total.	Good ears.	Nubbins.	Av. ears.		Good ears.	Nubbins.	Total.	Good ears.	Nubbins.	Av. ears.		Good ears.	Nubbins.	Total.	Good ears.	Nubbins.	Av. ears.		Good ears.	Nubbins.	Total.	Good ears.	Nubbins.	Av. ears.
1	2,400	4,440	6,840	68	28	30	30	2,400	4,320	6,720	58	29	41	60	2,760	6,480	9,240	50	25	31	92	3,240	3,840	7,080	50	21	34
2	1,080	2,160	3,240	58	24	32	32	1,200	6,360	7,560	48	21	26	61	1,920	9,480	11,400	39	22	22	94	5,040	4,440	9,480	48	26	37
3	840	4,080	4,920	43	24	30	33	1,080	5,280	6,360	44	22	29	62	2,640	4,920	7,560	52	27	34	95	2,640	7,200	9,840	51	26	32
4	2,640	4,200	6,840	55	30	35	34	1,200	6,600	7,800	55	21	26	63	2,640	5,520	8,160	48	26	34	96	3,000	5,640	8,640	55	26	36
5	4,080	5.520	9,600	46	25	32	35	1,080	5,400	6,480	50	22	28	64	1,800	8,040	9,840	53	29	35	97	3,480	3,720	7,200	57	38	40
6	2,520	5,400	7,920	58	29	41	36	1,200	5,280	6,480	43	21	23	65	2,640	3,720	6,360	52	26	35	98	2,160	8,040	10,200	42	22	27
7	2,280	2,400	4,680	58	34	38	37	1,200	4,320	5,520	40	24	25	66	2,040	7,920	9,960	53	27	31	99	1,440	7,920	9,360	44	27	29
8	3,000	8,280	11,280	48	25	40	38	960	5,160	6,120	44	23	27	67	3,120	5,040	8,160	50	27	34	101	1,200	7,800	9,000	45	21	26
9	3,000	8,280	11,280	48	25	28	39	2,400	6,240	8,640	44	23	28	68	840	6,720	7,560	32	22	22	102	3,000	5,760	8,760	54	30	39
10	1,440	6,600	8,040	50	24	29	40	2,640	6,600	9,240	48	21	30	69	2,160	6,120	8,280	44	30	29	103	3,000	6,600	9,600	50	25	33
11	2,760	7,320	10,080	58	30	36	41	1,800	6,600	8,400	50	20	30	70	840	8,280	9,120	39	20	20	104	1,920	7,200	9,120	48	26	31
12	1,320	6,120	7,440	68	36	37	42	2,160	7,680	9,840	49	22	30	71	3,720	5,520	9,240	48	24	36	105	5,040	4,320	9,360	55	28	41
13	2,884	6,840	9,724	53	25	34	43	2,760	4,320	7,080	52	25	33	72	3,840	6,240	10,080	34	20	25	106	2,400	6,840	9,240	44	22	28
14	2,160	7,560	9,720	50	27	32	44	1,680	7,560	9,240	50	28	30	73	3,360	7,440	10,800	36	18	28	107	1,800	6,960	8,760	60	31	34
15	1,200	8,400	9,600	50	25	29	45	2,280	6,000	8,280	54	29	37	74	2,760	7,200	9,960	40	22	31	108	2,400	3,720	6,120	66	25	48
16	2,160	5,520	7,680	65	25	33	46	2,640	5,160	7,800	50	26	31	75	2,400	7,560	9,960	33	17	23	109	960	8,040	9,000	47	26	35
17	720	7,560	8,280	71	33	38	47	1,680	6,840	8,520	52	25	31	76	1,560	4,200	5,760	69	24	31	110	3,720	5,040	8,760	65	31	42
18	2,160	7,560	9,720	53	23	30	48	2,520	6,120	8,640	48	24	27	77	2,640	7,200	9,840	44	28	37	111	3,000	4,080	7,080	62	27	37
19	3,600	6,720	10,320	53	21	32	49	3,480	6,120	9,600	43	24	28	78	1,560	9,360	10,920	40	19	25	112	3,120	4,920	8,040	51	26	35
20	3,000	4,680	7,680	56	29	38	50	3,840	5,760	9,600	52	27	35	79	1,440	8,880	10,320	33	20	28	113	1,920	7,800	9,720	42	18	22
21	1,440	6,240	7,680	56	25	29	51	2,160	4,920	7.080	53	29	35	80	2,400	6.960	9,360	40	22	27	114	1,440	8,400	9,840	71	26	35
22	2,280	4,680	6,960	63	27	41	52	3,360	5,640	9,000	48	28	35	81	2,280	4,200	6,480	43	25	29	115	4,200	6,480	10,680	60	22	41
23	1,440	5,400	6,840	56	26	33	53	1,920	6,720	8,640	39	25	31	82	2,280	5,400	7,680	57	29	33	116	1,200	3,600	4,800	13	9	10
24	2,160	4,080	6,240	43	21	21	54	2,040	5,640	7,680	60	23	28	83	1,920	7,560	9,480	58	26	28	117	2,400	4,800	7,200	24	9	15
25	3,840	5,040	8,880	55	25	38	55	2,640	6,000	8,640	60	24	33	84	3,600	6,840	10,440	47	26	35	118	2,640	3,960	6,600	39	23	23
26	960	5,160	6,120	50	26	28	56	3,000	6,840	9,840	48	30	33	85	2,400	6,720	9,120	45	25	31	119	2,400	3,600	6,000	28	11	18
27	1,320	4,800	6,120	57	24	32	57	3,480	1,920	5,400	57	38	59	86	840	6,840	7,680	57	25	26							
28	2,400	3,000	5,400	65	25	42	58	1,920	3,360	5,280	64	25	33	88	3,360	5,520	8,880	55	32	41							
29	4,440	3,000	7,440	57	25	45	59	3,000	4,320	7,320	48	29	36	91	1,560	3,960	5,520	40	27	34							

VARIETY TESTS, YIELD, 1893.

Plat.	Name of variety.	Per ct. water in shelled corn as husked.	Lb. per acre ear corn as husked.	Lb. ear corn per bu. as shelled.	Lb. as husked to make bushel air-dry.	Bu. shelled corn per acre.		
						As shelled.	Air-dry.	Loss drying.
1	Leaming	25	2420	66.4	78.8	36.4	30.7	5.7
2	Helms improved	37.5	1250	76	107.8	16.4	11.6	4.8
3	Piasa queen	31.2	1540	74.7	96.2	20.6	16	4.6
4	Piasa king	34.4	2370	74.1	100.4	32	23.6	8.4
5	Murdock	18.1	3200	67.8	73.7	47.2	43.4	3.8
6	Blue River	25	4160	77.5	92	53.7	45.2	8.5
7	Fisk's white	18.2	3240	72.3	78.6	44.8	41.2	3.6
8	Ohio white dent	24.2	2520	80.2	94.1	31.4	26.8	4.6
9	White variety (no name)	24.2	1840	80.2	94.4	22.9	19.5	3.4
10	Dunlap's white	19	2300	73.1	81	31.5	28.4	3.1
11	Hess white	27.6	3600	71.8	88.2	50.1	40.8	9.3
12	Boone county white	31.8	3290	76.6	100	42.9	32.9	10
13	Burr's white	23.4	2950	72.2	83.8	40.9	35.2	5.7
14	Champion white pearl	21.9	3520	73.5	83.8	47.9	42	5.9
15	Ivory dent	28	2690	75.2	93.1	35.8	28.9	6.9
16	White variety (no name)	25.6	2710	74.4	89.1	36.4	30.4	6
17	White beauty	32.4	3480	76	100	45.8	34.8	11
18	Mills county white	21.6	2670	70.9	80.4	37.6	33.2	4.4
19	White variety (no name)	27.6	3200	74	90.9	43.2	35.2	8
20	Champion white pearl	24.7	3200	72.5	85.8	44.1	37.3	6.8
21	Farmers' interest	22	2250	68.1	77.6	33.1	29	4.1
22	Star corn	28.3	2630	77.5	96.3	33.9	27.3	6.6
23	Prentice corn	27.8	2240	75.3	92.6	29.7	24.2	5.5
24	Woodhull	24.5	2100	80.6	95.2	26.1	22	4.1
25	Pride of Kansas	31.3	3590	78.1	101.1	46	35.5	10.5
26	Chester county mammoth	26.5	1530	73	88.4	20.9	17.3	3.6
27	Champaign county prolific	31.5	2050	71.7	93.2	28.6	22	6.6
28	Early mastodon	22.4	2370	73.1	83.7	32.4	28.3	4.1
29	Golden beauty	28.4	3290	72.7	90.4	45.3	36.4	8.9
30	Cloud's early	27.9	2850	76.1	93.4	37.4	30.5	6.9
32	Log cabin	26.1	2040	74.7	89.9	27.3	22.7	4.6
33	Fisk's yellow	31	1900	75.6	97.4	25.1	19.5	5.6
34	Bickerdike's early mammoth	28.9	2040	77.3	96.7	26.4	21.1	5.3
35	Clark's favorite	31.5	1760	85.5	111.4	20.6	15.8	4.8
36	Clarage	19	1670	68.7	75.6	24.3	22.1	2.2
37	Eclipse	30.2	1470	71.8	91.3	20.5	16.1	4.4
38	Yellow variety (no name)	23.7	1870	72	83.9	26	22.3	3.7
39	Baker's yellow	29.7	2260	68.5	86.9	33	26	7
40	California yellow	29.5	2730	71.2	89.8	38.3	30.4	7.9
41	Yellow variety (no name)	27.8	2300	68.9	84.9	33.4	27.1	6.3
42	" " "	29.2	2880	74.9	94.1	38.4	30.6	7.8
43	Munns	21.9	2390	69.2	78.9	34.5	30.3	4.2
44	Yellow variety (no name)	24.4	2890	71.1	83.8	40.7	34.5	6.2
45	Hughes	29.2	3110	78.4	98.4	39.7	31.6	8.1
46	Steward's improved	26	2580	72.2	86.9	35.7	29.7	6
47	Leaming	26.3	2570	71.6	86.5	35.9	29.7	6.2
48	Clark's Iroquois	22.6	2440	69.2	79.5	35.2	30.7	4.5
49	Murdock	29.2	2850	67.8	85.1	42.1	33.5	8.6
50	Burr Oaks Leaming	22.9	3390	72	83.1	47.1	40.8	6.3
51	Short stalk	27	2770	73.2	89.1	37.8	31.1	6.7
52	B. O. E. Ensilage	22.1	3250	71.5	81.3	45.4	40	5.4
53	Leaming	26.2	2850	74.4	89.6	38.3	31.8	6.5

VARIETY TESTS, YIELD, 1893—*Continued.*

Plat.	Name of variety.	Per ct. water in shelled corn as husked.	Lb. ear corn per acre as husked.	Lb. ear corn per bu. as shelled.	Lb. as husked to make bushel air-dry.	Bu. shelled corn per acre.		
						As shelled.	Air-dry.	Loss drying.
54	Sterling	28.9	2260	82.1	102.7	27.5	22	5.5
55	Improved Leaming	21.7	3160	72.5	98.4	36.5	32.1	4.4
56	Clark's Onarga	24.7	3150	70.6	83.6	44.6	37.7	6.9
57	Riley's favorite	19.8	3040	71	78.8	42.8	38.6	4.2
58	Edmonds	29.6	2010	64.4	81.4	31.2	24.7	6.5
59	Legal tender	26.3	2980	73	88.2	40.8	33.8	7
60	90-day	30.2	2830	73.5	93 7	38.5	30.2	8.3
61	Queen of the field	17.9	2510	69.4	75.1	36.1	33.4	2.7
62	Arleus	22.3	2700	71	81.3	38	33.2	4.8
63	Thomas corn	22.7	2630	72.5	83.5	36.3	31.5	4.8
64	Branson's climax	27.1	3530	70.8	86.5	49.9	40.8	9.1
65	Pride of the north	23.3	2350	67.2	78.1	35	30.1	4.9
66	Steward's improved	28.8	3180	70.3	87.8	45.2	36.2	9
67	Nims prolific	27.6	2830	72.4	89	39.1	31.8	7.3
68	Yellow variety (no name)	21	1900	77.3	87.2	24.6	21.8	2.8
69	Pride of Columbia	22.1	2670	67.5	77.2	39.6	34.6	5
70	Baker's white	16.9	1840	66.2	70.8	27.8	26	1.8
71	Waterloo extra early	29 2	2690	69.5	87.3	38.7	30.8	7.9
72	Minnesota king	32.1	2540	72.4	94.8	35.1	26.8	8.3
73	Early Huron	17.8	2690	66.1	71.5	40.7	37.6	3.1
74	Early Butler	21.4	2760	68.3	77.7	40.4	35.5	4.9
75	King of the earliest	16.7	2110	62.2	66.6	33.9	31.7	2.2
76	Little boss	23.6	2210	74.3	86.7	29.7	25.5	4.2
77	Cuban queen	26.6	3430	70	84.9	49	40.4	8.6
78	Wisconsin yellow	18.8	2520	67.9	74.3	37.1	33.9	3.2
79	" white	21.2	2850	72.4	81.7	39.4	34.9	4.5
80	Van's early	22.7	2390	65.6	75.6	36.4	31.6	4.8
81	Early golden	35.1	1980	74.7	102.6	26.5	19.3	7.2
82	Golden dent	35.4	3110	73.9	101.6	42.1	30.6	11.5
83	Murdock	23.7	3060	69.7	81.2	43.9	37.7	6.2
84	White variety (no name)	27.6	3770	78.3	96.2	48.2	39.2	9
85	Callaway's white	25	2910	76.6	90.9	38	32	6
86	Dunlap's white	23.4	2260	69.3	80.4	32.6	28.1	4.5
88	Leaming	29.9	3820	69.2	87.8	55.2	43.5	11.7
91	Helms improved	37	2240	77.9	109.8	28.8	20.4	8.4
92	Champion white pearl—Burr's white cross	24.8	2630	78.2	92.6	33.6	28.4	5.2
94	Leaming—Burr's white cross	26.8	3680	72.6	88.2	50.7	41.7	9
95	Edmonds—Murdock cross	21.1	3180	68.1	76.8	46.7	41.4	5.3
96	Clark's Onarga	30	2990	68.7	87.1	43.6	34.3	9.3
97	Riley's favorite	29	3280	69.5	87.2	47.2	37.6	9.6
98	Edmonds	25.9	2700	68.3	81.9	39.6	32.9	6.7
99	Edmonds—Burr's white cross	24.6	3020	67.6	79.9	44.7	37.8	6.9
101	Mixture *a*	33.7	2120	77	103.4	27.5	20.5	7
102	" *b*	34.7	3650	73	99.5	50	36.7	13.3
103	" *c*	25.6	3170	70.7	84.5	44.9	37.5	7.4
104	" *d*	23.9	2990	68.5	80.2	43.6	37.3	6.3
105	" *e*	26.7	3960	69	83.7	57.4	47.3	10.1
106	Hess white	27.2	2520	69.8	85.4	36.1	29.5	6.6
107	Bickerdike's early mammoth	35.7	3060	76.3	105.5	40.1	29	11.1
108	Yellow variety (no name)	28.2	2780	74.7	92.7	37.2	30	7.2
109	Log cabin	28.3	3090	78.4	97.2	39.4	31.8	7.6
110	Hughes	33.6	3870	77.8	104.3	49.7	37.1	12.6

VARIETY TESTS, YIELD, 1893—*Continued.*

Plat.	Name of variety.	Per ct. water in shelled corn as husked.	Lb. ear corn per acre as husked.	Lb. ear corn per bu. as shelled.	Lb. as husked to make bushel air-dry.	Bu. shelled corn per acre. As shelled.	Bu. shelled corn per acre. Air-dry.	Bu. shelled corn per acre. Loss drying.
111	Thomas	28.3	2610	72	89.4	36.3	29.2	7.1
112	Leaming	26.8	2970	70.7	86.1	42	34.5	7.5
113	Murdock	20.3	2150	67.7	75.7	31.7	28.4	3.3
114	Boone county white	30.4	3620	81.7	104.6	44.3	34.6	9.6
115	Burr's white	31.8	3930	71.8	93.6	54.8	42	12.8
116	Self-husking	16.3	580	68.9	73.4	8.4	7.9	.5
117	Golden dew drop	17.7	1010	68	73.7	14.9	13.7	1.2
118	Brazilian flour	35.2	1920	77.9	107.3	24.6	17.9	6.7
119	Longfellow	16.8	1030	67.6	72.5	15.2	14.2	1

Experiment No. 3. Corn, Time of Planting.

Experiments to test the effect of time of planting on yield and growth have been conducted for the past six years. The land used in 1893 was in clover during 1891 and 1892. The last of April and first of May it was treated with barnyard manure, at the rate of about thirty loads an acre, and plowed about five inches deep. The plats, seven in number, were each 6 x 60 hills in area. They were planted by hand with Burr's white corn, in hills 3 ft. 8 in. apart each way, six kernels a hill. The first plat was planted May 6th, and one plat was planted each week thereafter, till June 17th. After the corn was well up, it was thinned to four plants a hill. Plats 5 and 6 were cultivated four times, the others three times. The cultivation was done with surface cultivators and the remaining weeds removed with a hoe. Beginning June 13th, the height of each plant of two rows, running across the seven plats, was measured each week during its growth. The average weekly height in inches to the tip of tassel and upstretched leaf, for each plat, is given in the table.

September 23d, plats 1, 2, 3, and 4 were cut and shocked, and Oct. 11th the others were cut and shocked. When cut, the leaves and stalks of plat 7 were mostly green. When husked Oct. 28th to Nov. 1st, the number and pounds of ears were ascertained for each plat. Twenty-five pounds of ears from each plat was shelled, the cobs weighed, and a sample of the shelled corn sent to the laboratory for the determination of moisture.

The largest yield of air-dry corn, is from planting May 13th, with nearly as good results from planting May 6th. Taking the average of six years, the largest yield is from planting May 11th to 16th, with but little decrease in yield from planting any time from April 27th to May 23d. Corn planted May 27th, matured in 115 days. This is

RESULTS WITH CORN FROM PLANTING AT DIFFERENT DATES, 1893.

Plat No.	Date of planting.	Date of ripening.	When husked. No. of ears per acre.	When husked. Lb. of ear corn per acre.	When husked. Bu. shelled corn per acre.	Per cent. water.	Lb. ears when husked to make bu. shelled.	Lb. ears when husked to make bu. shelled air-dry.	Bu. per acre, air-dry.
1	May 6	Sept. 16	8631	3548	50.7	16.7	70	73.4	47.4
2	" 13	" 17	8118	3512	51.4	16.9	68.3	73.2	48
3	" 20	" 18	8181	3035	43.4	18.4	70	76.3	39.8
4	" 27	" 19	7920	2844	39.6	18	71.8	77.9	36.5
5	June 3	Oct. 6	6300	2792	38.4	21.4	72.7	82.4	33.9
6	" 10	" 10	7731	3172	44.2	23.9	71.8	83.9	37.8
7	" 17	" 15	6219	1899	25.8	25.8	73.6	88.3	21.5

AVERAGE HEIGHTS TAKEN WEEKLY IN INCHES TO TIP OF TASSEL AND LEAF, 1893.

Plat.		June 13	June 20	June 27	July 4	July 12	July 18	July 25	Aug. 1	Aug. 8	Aug. 23	Aug. 30	Sept 19
1	Leaf	16.5	31	44.5	61	76	85.5	92.5	93	92	91.5	90.5	88
	Tassel	.....	.....	.....	.....	.....	.....	88	91.5	91	89.5	89.5	90.5
2	Leaf	14.5	29	43.5	58	73.5	82.5	93.5	95	95.5	94.5	95	90
	Tassel	.....	.....	.....	.....	.....	.....	86.5	93.5	94.5	92.5	92.5	92
3	Leaf	9.5	20	34	46	63.5	72	81.5	84	86	84.5	85	81.5
	Tassel	.....	.....	.....	.....	.....	.....	76.5	81	84	83.5	83.5	81.5
4	Leaf	7	14	28	37	49.5	60	70	74	78	77.5	77.5	75
	Tassel	.....	.....	.....	.....	.....	.....	.....	73	79	78	77	77
5	Leaf	3.5	10	20.5	32.5	41.5	51.5	60	66.5	72	75.5	75	73.5
	Tassel	.....	.....	.....	.....	.....	.....	.....	56	68.5	75	75	75
6	Leaf	.....	6	14	23	35	47.5	59	66.5	74.5	78.5	78.5	78.5
	Tassel	.....	.....	.....	.....	.....	.....	.....	62	71	79.5	80.5	80
7	Leaf	.....	.....	7	12	23	33	40	46	54.5	66.5	69	67
	Tassel	.....	.....	.....	.....	.....	.....	.....	.....	.....	65.5	68	67.5

RESULTS WITH CORN FROM PLANTINGS AT DIFFERENT DATES, 1888—1893.

Dates.	Bu. air-dry corn per acre. 1888.	1889.	1890.	1891.	1892.	1893.	Av.
April 22—25	......	52	......	51	......	......	51.5
April 27—May 2	80	44	67	50	72	......	62.6
May 4—9	87	51	71	48	70	47	62.3
" 11—16	86	56	75	50	63	48	63
" 19—23	87	50	71	52	66	40	61
" 26—June 1	83	55	74	34	59	37	57
June 1—8	81	50	61	37	68	34	55.2
" 8—13	50	50	60	19	49	38	44.5
" 17—20	......	......	......	......	30	22	26

less time than required by either earlier or later planting. This, together with the fact that the first three plantings reached their maximum height about the same time, shows the more rapid growth of corn planted later in the season when the ground is warm, over that planted earlier when the ground is cold.

By very early planting, if a good stand is secured and the corn kept equally free from weeds, we may expect as large yields as from later planting. But for this locality the extra labor required to remove the weeds and the risk of a poor stand, will not justify planting earlier than about May 1st.

Experiment No. 4. Corn, Depth of Planting.

May 24, 1893, six rows, each 220 ft. in length, were planted with Burr's white corn, four kernels a hill, the hills and rows each being 3 ft. 8 in. apart. Row one was planted one inch deep, and each succeeding row one inch deeper than the preceding. The land was adjacent to that used for Experiment No. 5, and was in every way treated the same. As in former years, the shallow planting gave best results. From the table giving results for five years, it will be seen that the average number of ears per acre uniformly decreases from the shallowest to the deepest planting, and that, in general, the bushels per acre also decreased.

RESULTS WITH CORN FROM PLANTINGS AT DIFFERENT DEPTHS.

Depth in.	Ears per acre.						Bushels per acre.						Ears in a bushel.					
	1888.	1889.	1890.	1892.	1893.	Av.	1888.	1889.	1890.	1892.	1893.	Av.	1888.	1889.	1890.	1892.	1893.	Av.
1	11,070	10,530	9,608	8,280	8,316	9,561	109.7	83	77.8	65.8	51.3	77.5	101	127	124	126	162	128
2	9,630	10,080	9,385	8,640	7,992	9,145	88.4	83	72.8	64.7	48.7	71.5	109	121	129	133	164	131
3	10,440	8,190	9,831	8,910	6,750	8,824	100.8	51	70.3	62.7	40.7	65.1	104	161	140	142	166	143
4	9,630	9,540	7,485	9,450	7,236	8,668	88	87	58.4	70.3	40	68.7	109	110	128	135	181	133
5	8,280	8,820	8,491	7,020	5,886	7,699	73.1	81	62.3	56.5	33.4	61.3	113	109	136	124	176	132
6	5,940	10,440	8,389	7,290	4,590	7,330	60.3	92	60.3	58.5	29	60	98	113	139	125	158	127
7	.....	.....	.....	5,130	.....	5,130	.....	.....	.....	40.5	.....	40.5	.....	.....	.....	127	.....	127

Experiment No. 5. Corn, Thickness of Planting.

The land used was in clover in 1891 and 1892 and was treated with barnyard manure, at the rate of about 30 loads an acre, just before plowing. The plowing was done about two weeks before planting. May 24th, twenty rows, each 220 ft. in length, were planted with the varying number of kernels a hill and at the distance shown in the table.

In general, the ratio of stalks harvested to kernels planted, and the ratio of ears to stalks, increases as the thickness of planting decreases. The noticeably larger yield by the row having one kernel every three inches, was due to the fact that no corn was planted next to it till June 17th. This gave it a more favorable exposure. Excepting with this row the number of kernels a hill, from one to four, seemed to have little influence on the yield, the difference being due to the number of plants on a given area.

The yield of stover is greatest for the thickest rate of planting, but the bushels of corn is greater for thinner rates. Taking the average for five years, there seems to be but little difference between planting anywhere from 11,880 to 23,760 kernels per acre. If grown chiefly for the grain, the fewer the ears required to make the maximum yield the less the work in harvesting; but if much value is attached to the stover, the larger amount obtained by planting thicker might more than pay for the extra labor required to harvest the grain. If stover and corn are to be fed together, then it is pretty certainly better to plant thickly. This

RESULTS WITH CORN FROM PLANTINGS AT DIFFERENT RATES OF THICKNESS, 1893.

Kernels in a hill.	Inches between hills.	Per acre.					Ratio of stalks harvested to kernels planted.	Av. wt.		Ears harvested to 100 stalks.	Bu. per acre air-dry corn.					
		Kernels planted.	Stalks harvested.	Ears harvested.	Lb. stover.	Lb. ears.		100 stalks.	100 ears.		1888.	1889.	1890.	1892.	1893.	Average.
1	3	47520	35316	17550	6507	3726	.74	16	21	50	73	46.4	24.4	105.3	45.3	58.9
2	6	47520	34074	8802	6237	1377	.72	18	16	26	87.4	46.2	23.2	84.1	16.7	51.5
3	9	47520	34020	7344	6426	1174	.72	19	16	22	81.7	53.5	23.1	87	14.3	51.9
4	12	47520	33480	7722	6345	1444	.73	19	19	23	76.5	45.3	21.2	97.7	17.5	51.6
Av.		47520	34222	10354	6378.75	1930.2	.727	18	18	30	79.6	47.8	22.9	93.5	23.5	53.5
1	6	23760	18522	8478	4698	2241	.78	25	26	46	88.5	68.8	39.9	90.9	27.6	63.1
2	12	23760	17982	8424	4739	2241	.76	26	27	47	87.3	74	41.5	98.6	27.6	65.8
3	18	23760	19116	9882	5252	2646	.80	27	27	52	75.2	70.4	43.9	103.3	32.5	65.1
4	24	23760	17388	8856	5062	2511	.73	29	28	51	81.3	76.4	43.6	100.8	30.9	66.6
Av.		23760	18252	8910	4937.7	2409.7	.767	27	27	49	83	72.4	42.2	98.4	29.6	65.2
1	9	15840	10692	6480	3294	2525	.68	31	39	61	84.4	78.7	49.8	87.2	32.1	66.4
2	18	15840	12150	9018	4590	3645	.77	38	40	74	76	81.9	50.2	89.4	46.3	68.8
3	27	15840	11610	8802	4509	3321	.73	39	38	76	75.6	78.8	45.3	82.5	42.2	64.9
4	36	15840	11880	9342	4428	3821	.75	37	41	79	81.7	71.4	45.7	89.5	48.5	67.4
Av.		15840	11583	8410	4205.2	3328	.732	36	40	73	79.4	77.7	47.7	87.1	42.3	66.9
1	12	11880	9936	7884	3119	3537	.84	31	45	79	81.7	74.4	60.7	80	44.9	68.3
2	24	11880	8856	7452	2673	3051	.75	30	41	84	79.5	81.5	61.4	76.1	38.7	67.4
3	36	11880	9936	7398	3483	3510	.84	36	47	74	76	77.9	57.1	86.6	44.6	68.4
4	48	11880	9936	8424	3780	3915	.84	38	48	85	70.4	80.6	60.7	86	49.7	69.5
Av		11880	9666	7789	3263.7	3503.2	.817	34	45	81	76.9	78.6	59.9	82.2	44.5	68.4
1	15	9504	9866	7344	4320	4172	1.04	44	57	74	71.9	67.2	57.6	75.2	53	65
2	30	9504	9126	5832	4064	3119	.96	45	53	64	61.7	69.6	54.9	72.3	39.6	59.6
3	45	9504	8478	6588	3875	3875	.89	46	59	78	57.9	72.8	58.9	75.4	49.2	62.8
4	60	9504	8154	6048	2957	3024	.86	36	50	74	....	....	....	72.3	38.4	55.3
Av.		9504	8906	6453	3804	3547.5	.937	43	55	73	63.8	69.8	57.1	73.8	45.1	60.7
1	Av.	21701	16866	9547	4388	3240	.82	29	38	62	79.9	67.1	46.5	87.7	39.4	64.1
2	Av.	21701	16438	7906	4461	2687	.79	31	35	59	78.4	70.6	46.2	84.1	38	63.5
3	Av.	21701	16632	8003	4709	2905	.80	33	37	60	73.3	70.7	45.7	87	42.1	63.8
4	Av.	21701	16168	8078	4514	2943	.78	32	37	62	77.5	68.4	42.8	89.3	41.9	64

experiment would indicate that, as corn is ordinarily planted, there is less danger of getting too many plants than of getting too few. One chief reason why smaller yields are obtained from corn planted thickly is probably because many small ears are not husked.

Experiment No. 6. Corn, Planting in Hills or Drills.

The land used consisted of seven half acre plats. It was plowed in early May and planted May 12th to 18th with Burr's white corn. The corn was dropped by hand and covered with a hoe. The west half of each plat was planted four kernels per hill, 3 ft. 8 in. apart each way, and the east half, one kernel every 11 in., in rows 3 ft. 8 in. apart. The cultivation was the same on both parts, each being cultivated three times, and the weeds remaining were removed with a hoe. Sept. 6th to Oct. 23d the corn was cut and shocked. Oct. 21st to 28th the corn was husked and the yield ascertained. The stover was weighed as fed during November, December, and January. The accompanying table gives the yield per acre for each plat. As to the difference in the yields of corn, two plats are slightly in favor of drills and the other five in favor of hills, while the average is 1.6 bushels in favor of hills. The average yield of stover is slightly in favor of drills.

This experiment, like No. 5, both for this and previous years, seems to indicate that there is practically no difference between hills and drills, so far as yields are concerned.

RESULTS WITH CORN PLANTED IN HILLS AND DRILLS, 1893.

Plat No.	Yield per acre. (75 lb. per bu.)		Yield per acre, lb. stover.	
	Hills.	Drills.	Hills.	Drills.
1	25.9	22.1	3104	3040
2	19.7	18.9	1640	1944
3	23.7	19.7	2240	1920
4	28.6	30.7	1808	1784
5	33.9	34.4	2120	2312
9	43.2	40.8	2408	2592
10	50.9	48.3	2120	2276
Av.	32.3	30.7	2206	2267

Experiment No. 8. Corn, Frequency of Cultivation.

The land used for experiments No. 8, 9, and 10 was in clover during 1892, and was plowed, harrowed, and marked during the latter part of May. June 2d it was planted with Burr's white corn, four kernels a hill, the hills being 3 ft. 8 in. apart each way. The tract was divided into eleven plats, each 6 by 25 hills in area, which were cultivated as follows: Plats 1 and 7 had the weeds removed by scraping the surface lightly with a hoe and without other disturbance of the soil; 2 and 8 were cultivated shallow, ordinary; 3 and 9 deep, ordinary; 4 and 10 shallow, frequent; 5 and 11 deep, frequent, and 6 had no cultivation, the weeds being allowed to grow. The shallow cultivation was done with the "Tower" and the deep with a one-horse double shovel. For dates and frequency of cultivation see table.

The number of ears and the bushels per acre are given in the table for each mode of cultivation. In both shallow and deep cultivation, ordinary frequency gave better results than did very frequent cultivation.

RESULTS WITH CORN FROM SHALLOW AND DEEP CULTIVATED PLATS, 1893.

Kind of cultivation.	Yield per acre.		
	No ears.	Bu. corn	Av. bu. for 5 yr.
None, scraped with a hoe (2 plats)	8881.6	28.7	68.3
Shallow, ordinary "	9108.9	36.3	70.3
Deep, " "	8938.4	33.6	66.7
Shallow, frequent "	8881.6	35.9	72.8
Deep, " "	7616.8	30.6	64.5
None, weeds allowed to grow	None.	None.	....
Frequent, (average 4 plats)	8249.2	33.2	68.6
Ordinary, " "	9023.6	34.9	68.5
Shallow, (average 4 plats)	8995.2	36.1	71.5
Deep, " "	8277.6	32.1	65.6

CULTIVATION OF PLATS.

Date, 1893.	Plats 1 and 7.	Plats 2 and 8.	Plats 3 and 9.	Plats 4 and 10.	Plats 5 and 11.
June 15		Shallow		Shallow	
" 17					*Deep
" 19			Deep	Shallow	†Deep
" 22	Scraped	Shallow		Shallow	Deep
" 26			Deep	Shallow	Deep
" 29		Shallow		Shallow	Deep
July 3			Deep	Shallow	Deep
" 11		Shallow	Deep	Shallow	Deep
" 17				Shallow	Deep
" 20	Scraped				

*Plat No. 11 only. †Plat No. 5 only.

Experiment No. 9. Corn, Depth of Cultivation.

For care of crop see report on *Experiment No. 8*. By consulting the table in the same report it will be seen that shallow cultivation gave four bushels per acre more than deep. Contrary to results in former years, scraping the surface to kill the weeds failed to give as large yields as did deep cultivation. No cultivation, allowing the weeds to grow at will, failed to produce any corn, excepting two small cobs, having one kernel each. Taking the average of five years, shallow cultivation produced 5 9 bu. per acre more than deep, and scraping the surface 2.7 bu. more than deep.

Experiment No. 10. Corn, Effect of Root-pruning.

Every other row of 6 rows running across the west end of the 11 plats used in *Experiments No. 8 and 9* was root-pruned four inches deep. The pruning was done three times—June 23d, July 11th, and 24th—by placing a frame 12 inches square on the outside, over each hill, and drawing a guaged knife around the edge of it. When husked, the number and pounds of ears for each row of each plat were ascertained. The table gives 30 weights, involving 15 comparisons. In 12 of these, the unpruned gave larger yields than the pruned. Taking the total yield of each row running across the eleven plats, every comparison gives the largest yield for the unpruned, and the sum of the pruned and unpruned is in favor of unpruned for each of the five sets of two plats.

The average yield per acre is 7.2 bu. greater for the unpruned rows.

These experiments and similar ones in previous years suggest that shallow culture is better than deep; that the injury to the roots, which necessarily results from deep culture, reduces the yield; that good crops may be secured in this soil without other cultivation than scraping the surface to destroy weeds, and that the gain from unusually frequent cultivation usually does not equal the extra cost of such cultivation.

RESULTS WITH CORN IN PRUNED AND UNPRUNED ROWS, 1893.

	Row.	Yield of ear corn, pounds.							
		Plats 1 & 7	Plats 2 & 8	Plats 3 & 9	Plats 4 & 10	Plats 5 & 11	Sum of ten plats. No. ears.	Sum of ten plats. Lb. ears.	Yield per acre bu.
3	Unpruned	5.87	12	5.62	11.5	8.5	132	43.5	26.9
4	Pruned	5.87	8.25	6.87	10.12	7.5	121	38.62	23.9
5	Unpruned	8.25	14.75	8.25	14.25	10.75	158	56.25	34.8
6	Pruned	6.25	8.75	8.87	9.37	7.75	118	41	25.4
7	Unpruned	9.75	15	11.62	14.87	11	176	62.25	38.6
8	Pruned	6.37	11.75	9.25	9.25	11	145	47.62	29.5
	Total Unpruned	23.87	41.75	25.49	40.62	30.25	466	162	100.3
	Total Pruned	18.49	28.75	24.99	28.74	26.25	384	127.24	78.8

Experiment No. 23. Continuous Corn Cropping contrasted with a Rotation of Crops.

For eighteen years tests have been made of the yields of corn on half acre plats. On three of these corn has been grown continuously; on one it has alternated with oats; and on six, to which no manure or commercial fertilizer has been applied, it has been grown for two successive years in a six years' rotation. On one of the plats continuously in corn, barnyard manure has been applied annually at

CONTINUOUS CROPPING WITH CORN, AND ROTATION, 1888–1893.

	In corn annually since 1876.						In rotation since 1876. No manure or commercial fertilizers of any kind.																				
	Barn-yard manure applied annually.		Comerc'l fertilizers applied annually.		No fertilizers.		Corn and oats alternating.			Corn, oats, and clover.																	
	Plat No. 1.		Plat No. 2.		Plat No. 3.		Plat No. 4.			Plat No. 5.			Plat No. 6.			Plat No. 7.			Plat No. 8.			Plat No. 9.			Plat No. 10.		
	Grain, bu.	Stover, lb.	Grain, bu.	Stover, lb.	Grain, bu.	Stover, lb.	Crop.	Grain, bu.	Stover, lb.	Crop.	Grain, bu.	Stover, lb.	Crop.	Grain, bu.	Stover. lb.	Crop.	Grain, bu.	Stover, lb.	Crop.	Grain, bu.	Stover, lb.	Crop.	Grain, bu.	Stover, lb.	Crop.	Grain, bu.	Stover, lb.
1888	66.7	4640	57.4	3840	54.3	2575	Corn	49.5	3070	Oats	48.6	2145	Oats	48	1665	Cl'v'r	....	3030	Cl'v'r	....	3045	Corn	61.2	3120	Corn	46.4	3750
1889	77.4	....	45.9	....	43.2	....	Oats	37.4	1775	Cl'v'r	....	8080	Cl'v'r	....	6665	Cl'v'r	....	3060	Corn	56.4	....	Corn	50.3	....	Oats	59	3650
1890	55.1	3392	41.5	2680	48.7	2380	Corn	54.3	1332	Cl'v'r	....	3010	Cl'v'r	....	2900	Corn	61.9	2988	Corn	58.2	2664	Oats	....	....	Cl'v'r	....	4680
1891	44.1	3284	29.2	2400	28.6	2460	Corn	33.2	2100	Cl'v'r	....	2910	Corn	43.8	2554	Corn	33.9	2246	Oats	55.3	1930	Oats	54.4	1748	Cl'v'r	....	5180
1892	60.5	2610	32.7	1530	33.1	1490	Oats	37.2	1710	Corn	67.6	2920	Corn	56.5	2636	Oats	41	2090	Cl'v'r	....	2812	Cl'v'r	....	3332	Cl'v'r	....	4450
893	24	3072	19.3	1792	21.6	2080	Corn	29.6	1802	Corn	34.1	2216	Oats	57.5	2160	Oats	29.8	1438	Oats	24	1334	Corn	42	2500	Corn	49.6	2198

the rate of 24 two-horse wagon loads an acre; on one commercial fertilizers of different kinds have been applied; and on one no fertilizing material of any kind has been applied. The corn has been cut, and the stalks removed each year. The table gives the yields of the ten plats for the last six years.

In general, the yields from the plat manured with barnyard manure are larger than those from the plats in rotation without manuring; but the yield from this plat in 1893 was much smaller than that from the rotation plats. A like result was recorded in the exceptionally dry year of 1887. The yields from the plat to which no fertilizers were applied have practically equalled those from that to which commercial manures have been applied; but they fall far short of those from the rotation plats, and somewhat below those from the plat on which the corn was grown in rotation with oats.

Experiment No. 71. Corn, Effect of Time of Harvesting.

Experiments to test the effect of time of harvesting on yield of both corn and stover have been conducted for each of five years. The harvesting has usually been done at three stages of maturity, the early cutting being when the grain was mostly in the roasting ear stage, with husks and leaves all green; the medium cutting when the kernels were mostly glazed and a few of the leaves and husks becoming dry; and the late cutting when the corn was fully ripe, the leaves and husks being practically all dead.

The crop has always been shocked in the usual manner at the time of cutting and allowed to remain until well cured, before the husking and weighing. In addition to the results given in the table, for several years, the chemical composition and feeding value have been ascertained and will be given at some future time.

From the table we see that the yield of grain increases with lateness of harvesting in a marked degree, the average yields being to each other as 65, 83.5, and 100 for the early, medium, and late cuttings, respectively. The yield of stover has always been least for the medium cutting, and in three out of four cases greatest for the early cutting, the average yields being to each other as 100, 87.5, and 97 for the three cuttings, early, medium, and late, respectively.

YIELD PER ACRE FROM CORN CUT AT DIFFERENT STAGES OF RIPENESS.

	1888	1889	1890	1891	1893	Average.
Pounds ear corn per acre.						
Cut early—Corn mostly in roasting ear stage, husks and leaves green.	2001	3081	3025	2216	2280	2521
Cut medium—Ears mostly glazed, a few husks and leaves becoming dry	3501	3160	4257	2640	2600	3232
Cut late—Fully ripe, leaves and husks usually all dry..................	4240	3696	4752	3322	3360	3874
Pounds stover per acre.						
Cut early..................................		4006	3615	2485	3240	3436
Cut medium..................................		3454	3482	2130	2950	3004
Cut late..................................		4051	3717	2447	3080	3324

Experiment No. 89. Corn, Cross-fertilization.

In 1893, ten of the most promising of the crosses grown in 1892 were planted on plats of considerable size and at such a distance from each other as to prevent much pollen being carried from one plat to another. There was some diversity in elevation and drainage and probably also in the fertility of the soil, so that not much importance was attached to the comparative yields. Three plats from self-fertilized ears (ears that were fertilized with pollen from the stalks on which they grew) were planted adjacent to three plats of the same size and from the same cross, but from ears cross-fertilized (fertilized with pollen from stalks other than those on which they grew). In every instance the cross-fertilized ear produced the larger yield, and the stalks were visibly larger. Naturally the corn from the self-fertilized ears was more uniform in character than that from the cross-fertilized ones. The greater the difference of the parent varieties the more variable was the product. It is thought that after some years of careful selection, after crossing, corn fairly uniform can be produced. For methods of crossing, see bulletin No. 25, p. 199.

Besides the above, five plats were planted, each from a different crossbred ear, and four plats each from the first year's product of a different cross-bred ear. The former failed to produce a stand, the seed having been injured by weevils and the plats were planted later with Murdock. These plats were planted in Experiment No. 1.

The accompanying table gives the number of ears and bushels an acre for the four plats of cross-bred corn as compared with the individual and average yield of the parent varieties. The first named variety is, in each case, the female parent. In three out of the four cases the yield from the cross is greater than the average from the parent varieties, the average increase being 2.3 bu. an acre in favor of the crosses. In 1892 five crosses gave in every instance a larger yield than the average of the parent varieties, the average increase being 9.5 bu. an acre. It seems that cross-bred corn gives larger yields at least for the first and second years after crossing than an average of the parent varieties, but how long this greater fruitfulness will last is undetermined.

Farmers can produce cross-bred seed in considerable quantities in the following manner: Plant with one variety in one planter box and another variety in the other. Remove the tassels of one variety before they begin to shed pollen and the shoots of the same will be fertilized with pollen from the other variety, thus producing a direct cross. The seed should be selected from the rows from which the tassels have been removed.

RESULTS FROM CROSS-BRED CORN.

Plat.	Variety.	Yield per acre.	
		No. of ears.	Bu. air-dry corn.
	Champion white pearl	7680	37.3
13 & 115	Burr's white	10200	38.6
	Average	8940	38
92	Champion white pearl—Burr's white cross	7080	28.4
	Leaming (average 4 plats)	8070	34.6
13 & 115	Burr's white	10200	38.6
	Average	9135	36.6
94	Leaming—Burrs' white cross	9480	41.7
58 & 98	Edmonds	7740	28.3
	Murdock (average 4 plats)	9600	35.7
	Average	8670	32
95	Edmonds—Murdock cross	9840	41.4
58 & 98	Edmonds	7740	28.3
13 & 115	Burr's white	10200	38.6
	Average	8970	33.5
99	Edmonds—Burr's white cross	9360	37.8

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RATE OF GROWTH AND CHEMICAL COMPOSITION OF THE CORN PLANT.

Experiment No. 90. Corn, Rate of Growth.

This article gives a record of observations on the rate of growth in height and weight and on the chemical composition of the corn plant, as well as on the rainfall and temperature at this Station during four seasons from May to October.

The field work and the weather observations have been in charge of the agricultural department of the Station. The writer is responsible for the chemical analyses in 1890, 1891, and 1892, and the writing of this report from the observations on record. The work has already been briefly discussed in bulletins Nos. 13, 20, and 25 of this Station.

It is quite well known that experienced corn growers have an unwritten knowledge of what is good and bad corn weather. They have learned by their own observations through a number of years the climatic or meteorological conditions that are favorable or unfavorable to growing corn. This information has been gained without measuring a single corn plant or recording the amount of rain and heat from year to year. It is not uncommon to hear the remark that a certain shower is worth more to the corn than two inches of rain at a given time, and that the corn needs two days of soaking rain is another statement that may be frequently heard sometimes. But, although the weather of the future seasons cannot be accurately predicted, it is of interest to note what has been in the past the relation between the development of the corn plant and the weather. This has been done by actually measuring and weighing corn plants every week of their growth and noting the rainfall and temperature during the same time. A record of such observations has been made at this Station through the corn growing season of four years, 1889, 1890, 1891, and 1892.

Plan of the Experiment.

Each season, when the corn plants were about ten inches high, measuring from the ground to the tip of the upstretched leaves, a number of hills of nearly uniform size, with three plants in each, were selected and numbered. Each week through the season the height of these plants was measured and two or three hills (of three plants each) were cut off close to the ground, taken to the laboratory and analyzed. Thus a weekly record was obtained of the increase in height and weight of the corn plant and also of some of the changes in composition. The changes in weight and composition of the plants through the season were necessarily obtained from different plants each week. They could not be weighed and then left to grow again, as is done with animals in an experiment. The only thing possible was to begin with an even lot of plants and assume that those which were cut and analyzed each week were a fair sample of the whole and represented the general growth and development. Measurements of the height from the ground to the tip of the tallest leaf and to the top of the tassel, when present, were made of each plant. The number measured each week varied from 6 to 225 during the different years. The weight and composition per plant was obtained by analyzing the three plants in one hill as one sample. Excepting the first year, three hills of three plants each, making three samples, were cut and analyzed every week. From these analyses, including nine plants, the average composition per plant was calculated.

Very complete meteorological observations have been made daily at this Station since August, 1888. They are taken at 7 a. m., 2 p. m. and 9 p. m., and include the maximum, minimum, and mean temperature, height of barometer, direction and force of the wind, weather, as clear, fair, or cloudy, rainfall, and humidity. Some of these observations, particularly the temperature and rainfall, are given in this report for the purpose of comparing these meteorological conditions with the rate of growth of the corn during the different years.

THE SOIL.

The soil in which the corn was grown is the uniform black prairie soil of the University farm, tile drained. A different plat was used each of the four years the experiment was made.

The land used in 1889 had produced a crop of corn in 1888, with no manure; corn in 1887, with barnyard manure; and clover in 1886. The plat used in 1890 had produced crops of oats in 1888 and 1889. The corn of 1891 was planted on land which had raised a crop of corn in 1890, wheat in 1889, and clover in 1888, no manure. A plat of grass land which had produced a crop of hay in 1891, 1890, and 1889, was used for this experiment in 1892.

TIME OF PLANTING AND VARIETY OF CORN.

May 4th, 1889, Edmonds, yellow dent, was planted; May 5th, 1890, Burr's white; May 9th, 1891, Leaming; June 3d, 1892, Burr's white.

The influence of the soil and the variety of corn on the variations in the rate of growth during these four years cannot be exactly measured. The same variety of corn was planted in the two years 1890 and 1892. The varieties planted the other two years were similar, Edmonds being somewhat smaller and earlier.

The weekly observations giving the growth in height and weight, each year show that there was not the same rate of growth in any two years, but quite similar in some years and very different in others. The greatest variation is noticed between the two years when the same variety of corn was planted, and this suggests than the rain and heat were more influential on the rate of growth, than the difference in the variety of corn, as there was a great contrast in the weather of these two years, 1890 and 1892.

Measurements and Analyses made of the Plants.

The measurements made of the plants included the height of each from the soil to the tip of the tallest upstretched leaf, and to the tip of the tassel when present. The analysis included the determination of dry matter only in 1889. In 1890, 1891, and 1892, each of the three samples of corn cut weekly was analyzed more completely. An estimation was made of the dry matter, mineral matter or ash, protein or flesh-forming, nitrogenous matter, fiber, nitrogen-free extract which includes the starch, sugars, gums, etc., and ether extract that contains the fats and oils. In addition to this, an estimation of water was made in the corn plants cut in 1892.

June 10, 1889, fifteen pairs of hills were selected and numbered consecutively. The corn in one pair of these selected hills, was measured and cut weekly, and the amount of dry matter determined in each of these two samples, which contained three plants each.

June 2, 1890, sixty-three hills, as nearly alike as it was possible to find, were selected. They were numbered and divided off into 21 lots, of three hills each. One lot of three hills was measured and cut as in 1889.

June 12, 1891, seventy-five hills were divided into 15 lots of five hills each. Four of these hills were cut every week. Chemical analyses were made of each of three hills, so that during the growing season these analyses were made of triplicate samples taken each week. The fifth hill in each lot was left to grow, and was measured each week during the season. Each plant in the 75 hills was measured every week until it was cut, making a total of 3,159 measurements that year.

The spring of 1892 was very wet, hence the planting of corn was about one month late. This year weekly observations were made of the growth of the corn from the time it was planted. One hundred plants, drilled about 18 inches apart in a row, were selected for measuring. They were not cut for analysis. The same analyses as in previous years were made weekly of three hills of corn in this same plat and very near to the plants measured.

Details Recorded in the Tables and Charts.

The tables show for each year the variety of corn planted, date of planting, number of plants measured each week, with the extremes and average height per plant; the weight of dry matter per plant each week,

RATE OF GROWTH OF FIELD CORN, AND CHEMICAL COMPOSITION.

Edmonds yellow dent corn, planted May 4, 1889.

Week ending.		Plants measured.	Height of plants, in.		Field notes.	Dry matter per plant, grams.	Rainfall, in.	Av. daily temp., F.			Percentage composition of dry matter.				
			Extremes.	Average.				Mean.	Maximum.	Minimum.	Ash.	Protein.	Crude fiber.	Nitrogen-free extract.	Ether, extract.
June	10	6	6–9	7	....	.2	1.56	58°	77°	40°	....	....	....	....	....
	17	6	11–13	14	....	.8	2.44	62	78	46	....	....	....	....	....
	24	6	24--28	27	....	3.4	2.69	71	86	52	....	....	....	....	....
July	1	6	37–44	41	....	11.3	....	67	88	48	....	....	....	....	....
	8	6	46 58	53	....	25.1	.06	73	89	52	....	....	....	....	....
	15	6	69-87	78	....	66.	2.31	75	90	63	....	....	....	....	....
	22	6	73–100	92	(*a*)	107.6	.78	72	90	50	....	....	....	....	....
	29	6	95–109	103	(*b*)	136	2.66	71	88	54	....	....	....	....	....
Aug.	5	6	110–119	111	....	196.3	....	68	83	49	....	....	....	....	....
	12	6	102–117	110	(*c*)	227.2	.6	69	84	50	...	....	....	....	....
	19	6	96–120	110	(*d*)	241.5	....	67	84	51	....	....	....	....	....
	26	6	106–124	111	(*e*)	316.5	....	71	89	49	....	....	....	....	....
Sept.	2	6	96–117	107	(*f*)	302.1	1.3	67	87	45	....	....	....	....	....
	9	6	106–114	108	(*g*)	344.8	....	70	88	47	....	....	....	....	....
	16	6	91–140	108	(*h*)	392	....	53	73	35	....	....	....	....	....

Burr's white dent corn, planted May 5, 1890.

Week ending.		Plants measured.	Height of plants, in.		Field notes.	Dry matter per plant, grams.	Rainfall, in.	Av. daily temp., F.			Percentage composition of dry matter.				
			Extremes.	Average.				Mean.	Maximum.	Minimum.	Ash.	Protein.	Crude fiber.	Nitrogen-free extract.	Ether, extract.
June	2	9	13–15	14	....	.7	1.12	68	87	42	....	....	....	....	....
	10	9	20–27	23	....	2.8	.05	72	88	51	17.4	27.9	....	....	3.6
	17	9	32–43	38	....	10	2.41	68	84	47	14.4	24.5	21.3	36.4	3.4
	24	9	57–68	61	....	32.3	1.34	74	90	62	14.7	17.7	25.2	40.1	2.3
July	1	9	73–92	87	....	58.1	....	81	96	64	14.9	15.8	34.6	33.3	1.3
	8	9	90–105	98	(*a*)	136	....	72	94	45	9.8	11.4	28.8	49	.1
	15	9	95–120	111	....	179	2.04	73	97	50	8.2	11.4	29.9	49.2	1.3
	22	9	104–123	119	....	229	....	72	94	55	7.9	10	30	51.2	1.2
	29	9	103–126	114	....	289.6	.79	72	97	51	6.5	8.5	27.9	56.2	1
Aug.	5	9	100–130	112	....	298	.07	76	96	50	6.4	8.6	28.3	55.4	1.4
	12	9	89–124	109	....	293	1.08	68	92	47	6.6	8.6	24.5	58.6	1.6
	19	9	96–112	108	(*b*)	344.6	.38	68	88	45	6.4	7.3	22.1	62.1	2.1
	26	9	97–128	117	....	393	.4	63	85	39	5.7	7.5	25.9	58.8	2.1
Sept.	2	9	99–126	114	(*c*)	385	.31	71	89	46	5.7	7.1	21.5	63.8	1.9
	9	9	105–122	113	(*d*)	421	.51	59	78	33	5.3	7.3	19.9	64.9	2.5
	16	9	94–120	106	(*e*)	344	....	57	78	35	5.8	7.8	22.6	61.5	2.3
	23	9	100–118	114	....	349	.37	54	75	33	4.9	7.5	22.7	62.6	2.3
	30	9	99–123	112	....	442	1.4	60	75	46	3.7	6.7	20.2	66.8	2.6

FIELD NOTES, 1889.

(*a*) Tassels showing.
(*b*) All in tassel, bloom and silk.
(*c*) Silks dead.
(*d*) Soft milk stage.
(*e*) Passed milk.
(*f*) All glazed.
(*g*) Milk to ripe.
(*h*) All ripe.

FIELD NOTES, 1890.

(*a*) Full tassel.
(*b*) Milk stage.
(*c*) Dented, husks drying.
(*d*) One-half leaves dry.
(*e*) Ripe.

RATE OF GROWTH OF FIELD CORN AND CHEMICAL COMPOSITION—*Continued.*

Leaming corn, planted May 9, 1891.

Week ending.	Plants measured.	Height of plants, in.		Field notes.	Dry matter per plant, grams.	Rainfall in.	Av. daily temp. F.			Percentage composition of dry matter.				
		Extremes.	Average.				Mean.	Maximum.	Minimum.	Ash.	Protein.	Crude fibre.	Nitrogen-free extract.	Ether extract.
June 10	225	11–26	16	....	.....	.5	66	90	50	....	....	....	....	....
17	225	23–43	31	....	4.5	.23	70	92	49	11.2	27.6	23.3	35.7	2.2
24	213	32–64	47	...	20	1.02	74	92	58	11.8	24.1	25.4	36.7	1.9
July 1	201	50–84	65	....	30.4	.33	75	93	53	11.5	19.1	28.1	39.4	1.9
8	189	57–91	73	....	50	.07	69	89	47	10.5	19.1	29.2	39.5	1.6
15	177	59–102	84	....	114.3	.38	71	93	45	9	15.7	30.6	42.8	1.9
22	165	64–111	96	(*a*)	161.6	.13	70	93	52	7.9	12.1	29.1	49.3	1.6
29	153	81–115	98	(*b*)	161.2	.83	69	93	42	7.1	11.3	28.1	51	2.4
Aug. 5	141	82–116	93	(*c*)	215.1	.01	71	93	51	6	10.8	26.7	54.6	1.8
12	129	82–118	98	....	165.4	1.35	74	99	54	6.9	10.8	28.6	51.2	1.5
19	117	82–118	97	(*d*)	257	1.28	75	96	64	6.2	10.3	27.5	53.9	2
26	105	82–115	97	(*e*)	295	.22	62	83	40	5.7	9.3	24.7	57.6	2.6
Sept. 2	93	81–114	97	(*f*)	349.5	.35	63	90	41	5.1	8.5	21.7	61.7	2.9
9	81	81–114	96	...	320	....	64	88	41	5.1	8.9	20.4	62.8	3
16	69	81–113	93	(*g*)	290	....	76	95	55	5.2	9.7	19.7	62.5	2.8
23	....	....	....	....	324	.06	72	96	46	4.4	9	18.6	64.9	3.1

Burr's white corn, planted June 3, 1892.

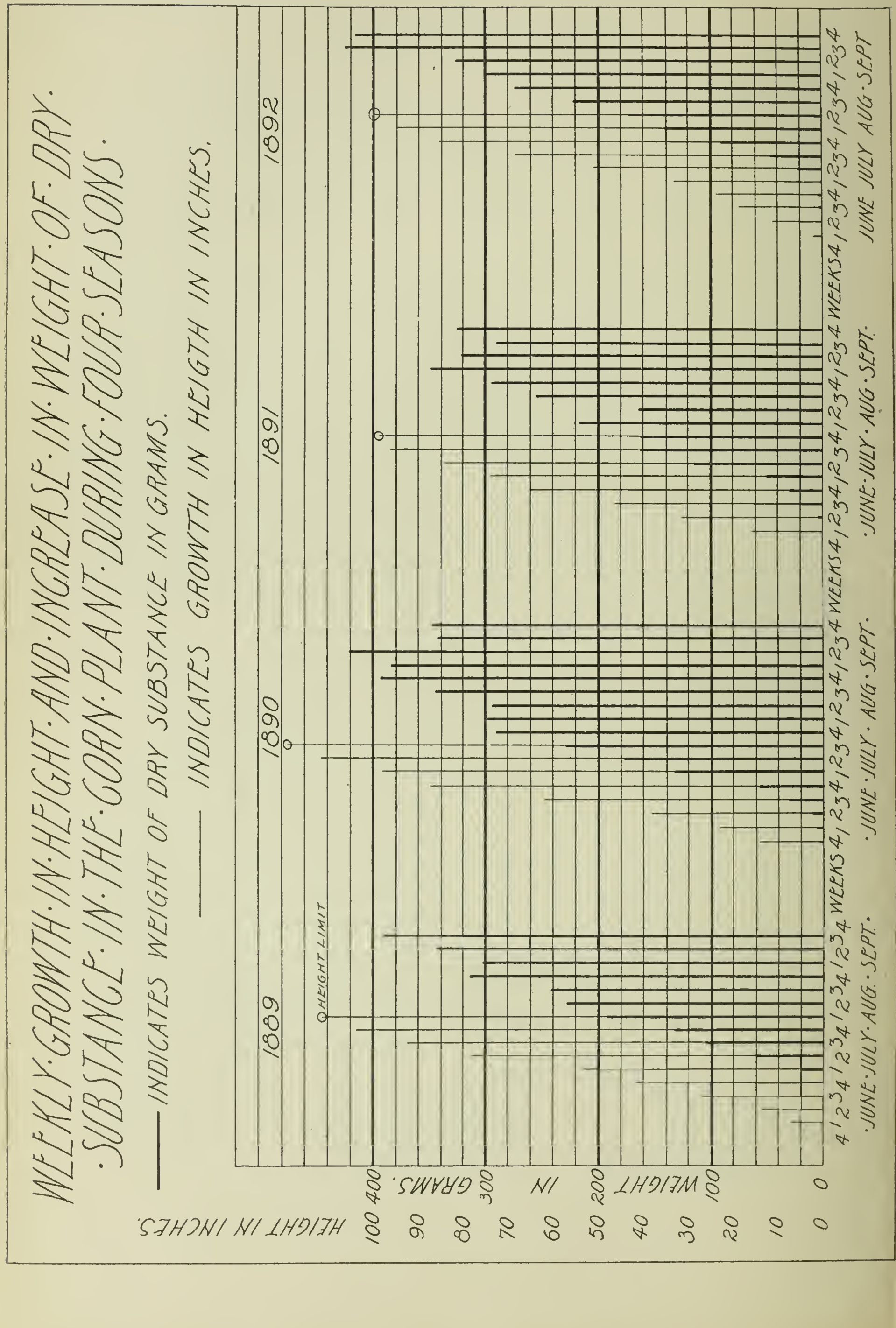
Week ending.	Plants measured.	Height of plants, in.		Field notes.	Dry matter per plant, grams.	Rainfall in.	Av. daily temp. F.			Percentage composition of dry matter.				
		Extremes.	Average.				Mean.	Maximum.	Minimum.	Ash.	Protein.	Crude fibre.	Nitrogen-free extract.	Ether extract.
June 10	100	....	2	....	.....	.30	66	82	42	....	....	...	....	....
17	100	2–17	11	....	......	.18	73	62	40	....	....	....	...	....
24	100	7–24	17	....	1.7	4.02	75	84	37	17.4	26.3	18.4	35.9	....
July 1	99	10–34	24	....	3.3	.86	68	80	49	13.4	24.4	21.6	34.5	....
8	98	12–43	33	....	9.1	1.32	66	84	49	14.1	22.8	25.3	33.9	3.7
15	97	25–67	51	....	20.8	.09	73	91	52	11.4	20.1	26.5	38.3	3.6
22	96	36–90	68	....	49	.82	78	94	58	8.5	17.3	28.3	42.5	3.4
29	94	40–110	86	....	90.8	.27	77	90	51	7.3	12.2	28.8	48	3.7
Aug. 5	94	50–119	95	(*a*)	141.4	1.93	61	82	46	6.6	10.8	29.8	49.6	3.2
12	94	52–119	99	....	171	.42	74	90	61	6	9.5	29	52.9	2.5
19	94	54–119	100	....	221	....	71	92	51	5.9	9.1	27.7	54.8	2.4
26	93	53–119	89	....	274.7	.08	68	96	30	6.6	9.5	26.9	54.8	2.2
Sept. 2	92	51–124	86	....	300.4	.19	72	93	54	5.7	7.9	23.8	59.7	2.7
9	92	51–125	88	....	329.7	.74	62	94	56	5.7	8.7	22.9	60	2.6
16	...	....	....	....	425.5	....	74	90	53	5.2	8.2	20.8	62.8	2.9
23	....	....	....	....	417.5	....	66	90	47	4.9	7.8	19.3	64.9	3
30	....	....	....	....	422.3	...	61	73	42	4.7	6.7	21	64.7	2.8
Oct. 7	....	....	....	....	412	....	56	....	....	4.2	8	20.7	64	3

FIELD NOTES, 1891.

(*a*) Full tassel.
(*b*) Silk all out.
(*c*) Silk dead.
(*d*) Roasting ear stage.
(*e*) Denting.
(*f*) Husks turning brown.
(*g*) 50 per cent. dead.

FIELD NOTES, 1892.

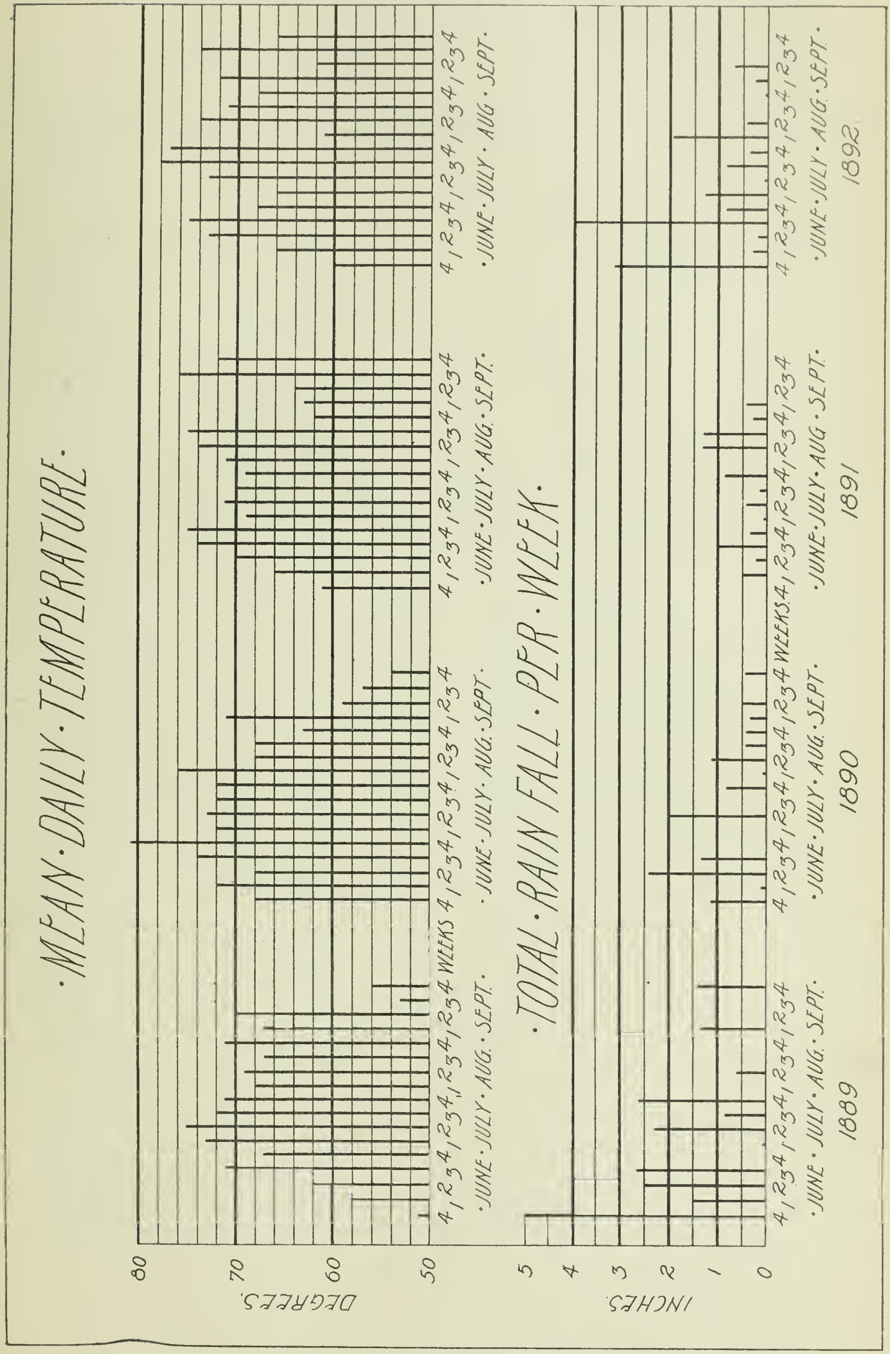
(*a*) Full tassel.



WEEKLY·GROWTH·IN·HEIGHT·AND·INCREASE·IN·WEIGHT·OF·DRY· ·SUBSTANCE·IN·THE·CORN·PLANT·DURING·FOUR·SEASONS·

━━ INDICATES WEIGHT OF DRY SUBSTANCE IN GRAMS.

—— INDICATES GROWTH IN HEIGTH IN INCHES.


·MEAN·DAILY·TEMPERATURE·
·TOTAL·RAIN FALL·PER·WEEK·
DEGREES.
80
70
60
50
INCHES.
5
4
3
2
1
0
4,2 3 4,2 3 4,2 3 4,2 3 4 WEEKS
·JUNE·JULY·AUG.·SEPT.·
1889
1890
1891
1892

RELATION OF TEMPERATURE AND RAINFALL TO INCREASE IN HEIGHT AND DRY MATTER OF THE CORN PLANT.

	1889.				1890.			
	Temp. F.	Rain, in.	Per cent. of total ht.	Per cent of total wt.	Temp. F.	Rain, in.	Per cent. of total ht.	Per cent. of total wt.
April.								
1st week......	45°	....	....	....	50°	1.10	....	....
2d "	55	.05	....	....	54	1.4	....	....
3d "	57	.54	....	....	48	....	....	....
4th "	52	.02	....	....	54	1.61	....	....
Sum	......	.61	....	....	......	4.11	....	....
May.								
1st week......	57	......	....	....	50	.45	....	....
2d "	66	.38	....	....	54	1.62	....	....
3d "	66	.12	....	....	56	.27	....	....
4th "	51	5.02	....	....	68	1.12	12	....
Sum	......	5.52	....	....	......	3.44	12	....
June.								
1st week......	58	1.56	6.3	....	72	.05	7.5	0.6
2d "	62	2.44	6.3	0.2	68	2.41	12.6	1.7
3d "	71	2.69	11.7	0.5	74	1.34	19.3	5.2
4th "	67	......	12.6	2	81	......	21.8	6.1
Sum	......	6.69	36.9	2.7	......	3.8	61.2	13.6
July.								
1st week......	73	.06	10.8	3.5	72	......	9.2	18.5
2d "	75	2.31	22.5	10.4	74	2.04	10.9	10.2
3d "	72	.78	12.6	10.5	73	......	6.7	12
4th "	71	2.66	10	7.5	72	.79	....	14.5
Sum	......	5.81	65.9	31.9	......	2.83	26.8	55.2
August.								
1st week	68	......	7.2	15.3	76	.07	....	2
2d "	69	.6	....	8	68	1.08	....	....
3d "	67	......	....	3.5	68	.38	....	10.9
4th "	71	......	....	19.2	63	.4	....	3.8
Sum	......	.6	7.2	46	......	1.93	....	16.7
September.								
1st week......	67	1.3	....	....	72	.31	....	....
2d "	70	......	....	7.2	59	.51	....	14.5
3d "	53	......	....	12.2	57	......	....	....
4th "	56	1.44	....	....	55	.37	....	....
Sum	......	2.74	....	19.4	......	1.19	....	14.5

RELATION OF TEMPERATURE AND RAINFALL TO INCREASE IN HEIGHT AND DRY MATTER OF THE CORN PLANT.—*Continued.*

	1891.				1892.			
	Temp. F.	Rain, in.	Per cent. of total ht.	Per cent. of total wt.	Temp. F.	Rain, in.	Per cent. of total ht.	Per cent. of total wt.
April.								
1st week......	36°	.15	....	....	56°	3.11	....	....
2d "	52	1.87	....	....	37	.83	....	....
3d "	63	1.47	....	....	47	.73	....	....
4th "	58	.15	....	....	52	1.78	....	....
Sum	......	3.64	....	....	......	6.45	....	....
May.								
1st week......	51	......	....	....	63	1.34	....	....
2d "	59	.46	....	....	53	1.21	....	....
3d "	62	.43	....	....	55	2.19	....	....
4th "	61	......	12	....	60	3.12	....	....
Sum	......	.89	12	....	......	7.86	....	....
June.								
1st week......	66	.5	7	....	66	.3	2	....
2d "	71	.23	13	1.1	73	.18	8	....
3d "	74	1.02	17	4.6	75	4.02	7	.4
4th "	75	.33	19	2.8	68	.86	7	.3
Sum	......	2.08	56	8.5	......	5.36	24	.7
July.								
1st week......	69	.7	9	5.7	67	1.32	9	1.4
2d "	71	.38	10	18.3	73	.09	18	2.8
3d "	71	.13	11	13.5	78	.82	17	6.6
4th "	69	.83	2	....	77	.27	19	10
Sum	......	2.04	32	37.5	......	2.5	63	20.8
August.								
1st week......	72	.01	....	15.5	62	1.93	8	11.8
2d "	74	1.35	....	....	74	.42	4	7
3d "	75	1.28	....	12	71	......	1	11.8
4th "	63	.22	....	11	69	.08	....	12.5
Sum	......	2.86	....	38.5	......	2.43	13	43.1
September.								
1st week......	63	.35	....	15.5	72	.19	....	6.1
2d "	65	......	....	....	62	.74	....	7
3d "	76	......	....	....	74	......	....	22.3
4th "	72	.06	....	....	66	......	....	....
Sum	......	.41	....	15.5	......	.93	....	35.4

COMPARISONS OF OBSERVATIONS ON TEMPERATURE.

1889.	1890.	1891.	1892.
April. A gradual increase in temperature up to the last week, which was cooler than the two previous weeks. Extremes, 25°–75°	*April.* Average temperature, higher than in 1889. The third week, the coolest in the month. Extremes, 29°-80°	*April.* Unusually cold the first week, but grew warmer each week. Third week, warmer than usual for April. Extremes, 22°-81°	*April.* Unusually warm the first week and cold the second and third weeks, with an average temperature in the last week. Extremes, 26°-70°
May. First week, average temperature; second and third weeks, above average; last week, unusually cold. Extremes, 28°-91°	*May.* First week, average temperature; second and third weeks, cool; last week, warm. Extremes, 33°-87°	*May.* First week, below average. Some hot days in last three weeks, with about an average mean. Extremes, 24°-91°	*May.* First week, warm. The remainder of the month cold. Highest in last week, 80°. Extremes, 37°-94°
June. The whole month a little cooler than June of the other three years. Extremes, 40°-88°	*June.* First week, warm; second and third weeks, about average temperature; last week, hot, temperature up 96°. Extremes, 47°-96°	*June.* The weather was warm, but not excessively so. Extremes, 49°-93°	*June.* Second week was warmest, and the last rather cool. Extremes, 49°-94°
July. Average temperature for July, warmer in second than last week. Extremes, 50°-90°	*July.* Temperature reached 97° in both second and third weeks. Extremes, 45°-97°	*July.* Cool first week and a mean temperature, a little below average, with some hot days. Extremes, 42°-93°	*July.* Cool the first week, very hot the third and fourth weeks, with an average temperature of 78°. Extremes, 46°-97°
August. A little below average temperature, except last week. Extremes, 50°-89°	*August.* First week hot, with average of 76°. Remainder of the month about average temperature. Extremes, 39°-96°	*August.* Very hot in second and third weeks, but cool in last week to a mean temperature of 62°. Extremes, 40°-99°	*August.* Mean temperature a little below average in first week, but above during remainder of the month. Extremes, 47°-94°
September. First week, average temperature; second week, warm; last two weeks, cooler. Extremes, 32°-88°	*September.* First week, warm; but cooler the remainder of the month. Extremes, 33°-89°	*September.* First two weeks, about average temperature; the third and fourth weeks, very hot. Extremes, 41°-96°	*September.* Temperature did not go to either extreme throughout the month. Extremes, 35°-73°

Comparison of Rainfall and Humidity.

1889.	1890.	1891.	1892.
April. Clear and dry; one-half inch rain in third week only. *Humidity decreasing from first of month.	*April.* Average amount of rain, about 1½ in. per week, except third week clear and dry. Humidity decreased.	*April.* Average amount rain, but nearly all fell in two middle weeks. Humidity high.	*April.* Very wet, especially in first and last weeks, 3 in. first week and 2 in. fourth week. Humidity high.
May. No rain in the first three weeks, but in fourth week the largest rain in any one week of this record.	*May.* Average amount rain. The greatest fall, 1.6 in., during second week. Humidity high first week and decreased to low last week.	*May.* Very dry, less than 1 in. rain during the month. Low humidity in second week, but about average in other weeks.	*May.* Very wet, over 1 in. rain every week, with 2 and 3 in. during last two weeks. Very high humidity second and third weeks.
June. Very wet except last week. No rain. High humidity second week and about average the rest of the month.	*June.* No rain first and fourth weeks, but considerable in the second and third weeks. Very low humidity in first week, about average the remainder of the month.	*June.* Rather small amount of rain, about 2 in. quite evenly distributed through the month. Humidity high first week, low fourth, and average second and third weeks.	*June.* Very little rain first and second weeks, but a great deal in third, and average amount in last. Humidity high first week, average through the rest of the month.
July. No rain first week, but 2 and 3 in. in second and fourth weeks. Humidity about average for some years, though not high.	*July.* No rain in first and third weeks, 2 in. second, 1 in. fourth week. Rather under the average humidity, but quite uniform through the whole month.	*July.* Almost no rain, except 1 in. during fourth week. Humidity low in second week, but high in fourth week.	*July.* 1¼ in. rain in first week, and 1 in. in third week, but dry in second and fourth weeks. Humidity average in first and fourth weeks, high in second and low in third.
August. Only ½ in. rain during the month, in second week. Average humidity through the whole month.	*August.* About 2 in. rain, mostly in second week of month. Humidity rather low, except the last week.	*August.* About 2 in. rain in second and third weeks. Humidity low in first week and high in third week, with average during second and fourth weeks.	*August.* Two in. rain first week, ½ in. second week, and none in last two weeks. Humidity above average in first and fourth weeks.
September. One-half in. rain first and fourth weeks. Second and third weeks dry. Humidity above average, especially in fourth week.	*September.* Nearly ½ in. rain in each, first, second, and fourth weeks, but none in third. Humidity about average for September.	*September.* Less than ½ in. rain during the whole month. Humidity very low.	*Septemher.* Less than 1 in. rain during first and second weeks, and none in third and fourth weeks. Humidity high in second and average the rest of the month.

*Humidity is the per cent of moisture in the air when rain equals 100 per cent.

together with the chemical composition of this dry matter. This shows the amount of ash, protein, fiber, nitrogen-free extract, and ether extract in 100 lbs. of dry matter of the plant each week of its growth. The tables also show the inches of rainfall, with the extremes and mean temperature observed every week, and some field notes made of stage of growth of the plant at various times in the season. These field notes were made by a different person each year, which fact accounts for the lack of uniformity in the number and wording of these observations.

A short summary of the weather in each of the six months of the four seasons isgiven on pp. 370-1. This affords an opportunity of comparing the temperature and rainfall of the same month in different years and of the different months of each year, and shows when sudden changes of temperature or rainfall occurred, the weather at the corresponding time in other years, and what influence it seemed to have on the corn plant, thus supplying evidence for judging the effect on corn growth of similar meteorological conditions in the future.

A summary of both weather and corn growth observations is given on page below. Also the temperature and rainfall for April as well as the corn growing months, the per cent of the total growth in height made each week, and the percentage of increase of dry matter gained by the plant every week.

SUMMARY OF WEATHER AND CORN GROWTH.

1889.

The month of April was cool and dry; only about one-half an inch of rain fell. The corn was planted the first week in May. There was no rain, and about average temperature in May, until the last week, when it was unusually cool and 5 in. of rain fell. This was the largest rainfall in any one week of this four years' record. It so checked the corn growth that although seed had been planted four weeks the plants were only about 7 inches high on June 10th. The whole month of June was rather cool and very wet, except the last week. During June the plants reached a height of 41 in., which was about 37 per cent of their total height. At this time they contained but about 3 per cent of their total growth in dry matter. No extremes of temperature occurred in July, but nearly 6 in. of rain fell. The plants grew about 56 per cent of their total height and gained 32 per cent of their total dry weight. The weather in August was rather cool and dry, with only one-half an inch of rain. The corn reached its total growth in height the first week in August, when it grew 7 per cent of its total height. The increase in weight of dry matter amounted to 46 per cent of its total dry weight. September had about the average temperature and rainfall for that month. The corn plant reached its greatest weight of dry matter in the third week of September, the increase being during the month 19 per cent of its total weight of dry matter.

Briefly stated, the season of 1889 was cool and dry before planting, cold and wet just after planting, with nearly average meteorological conditions the remainder of the season. The corn plant reached its greatest height the first week in August, making about one-third this growth in June and two-thirds in July. It continued to increase in weight of dry matter until the last week in September, gaining about 3 per cent of it in June, 32 per cent in July, 46 per cent in August, and 10 per cent the first week in September.

1890.

The rain in April and May was quite evenly distributed through the months. The temperature was warmer than in 1889. Corn was planted the first week in May, as in 1889, but it had reached a height of 23 in. June 10th, while in 1889 it was only 7 in. tall at this date. The weather in June, 1890, was hot and the rainfall nearly 4 in. Corn grew 61 per cent of its total height and gained nearly 14 per cent of its dry weight, as compared with 37 per cent and 3 per cent, respectively, in 1889, although the seed had been in the ground the same number of days each of the two years. In July there was some very hot weather and about 3 in. of rain. The corn plant reached its maximum height the third week in July and grew about 27 per cent of its total height during the first three weeks of this month. It increased each week in dry weight 10 to 18 per cent, making a growth of about 55 per cent of its total weight of dry matter in July. August and September were hot and dry. There was a gain of about 17 per cent of dry matter in the corn plant in August and 15 per cent in September. The maximum weight of dry matter was reached the second week in September.

1891.

In rainfall and temperature during the corn growing season, 1891 resembled 1890. Corn was planted May 9th. The temperature was about the average for May, but less than 1 in. rain fell during the month. Through June, July, and August rain was quite evenly distributed, amounting to 2 in. each in June and July, and 3 in. in August. No extremes in temperature were observed until the second and third weeks of August when 99° F. was recorded. A much greater number of corn plants was measured each week in this season than any other. The plants were 16 in. tall June 10th. They got 56 per cent of their total growth in height in June, 32 per cent in July, and reached their maximum height August 1st. They continued to grow in weight of dry matter until the second week of September. When the corn plant had reached its maximum growth in height, it had attained only 46 per cent of its total growth in dry matter. During the excessively hot August, with about 3 in. rain, the plants gained 38.5 per cent of their total growth in dry weight.

1892.

The months of April and May were excessively wet. Nearly three-eighths the annual rainfall, 14¼ in., came in these two months. June was also very wet; 5½ in. rain fell. This caused a very late planting of corn, so that June 10th plants were only 2 in. tall, while in 1890 they were 23 in. high on this date. In June, 1892, the plants grew 24 per cent of their total height, while in June, 1890, plants of the same variety of corn made a growth of 61 per cent of their total height. The temperature and rainfall were very favorable for corn growth in July, 1892, and the plants gained 63 per cent of their total growth in height, reaching their maximum height the second week in August, which was only one week later than former years, although there was a difference of four weeks in the date of planting seed. The plants also reached their maximum growth in dry weight the third week in September, which was no later than in 1889, and only one week later than in 1890; but the greater part of this growth was made in August and September, while in former years a much larger proportion of the growth in dry weight was made in July.

GROWTH AT DIFFERENT STAGES OF DEVELOPMENT.

The tables give data by which the growth of corn and the weather conditions for any week in the season can be compared with those of the corresponding week of the other three years. The plants were at such different stages of development, especially in the early months of the seasons, that in the discussion of the relation between weather and rate of growth of the corn plant, each year may be divided into two parts: First, before, and second, after, corn is one foot high. Climate and soil conditions have a great influence in accelerating or retarding the sprouting and start of corn. Assuming that the plants are on an equal footing when they have reached a certain height, we can trace from this second point the influence of meteorological conditions.

The corn was planted the first week in May in 1889, 1890, 1891, but not until June 3, in 1892, because of the great amount of rain in both April and May of that year. Between the date of planting and the time when the corn was one foot high there elapsed in 1889, 6 weeks; in 1890, 4 weeks; in 1891, 3½ weeks; and in 1892, two weeks. This shows that corn may reach one foot in height from 2 to 6 weeks after planting. The slow growth for six weeks in 1889 was evidently caused by the extreme dryness in April and three weeks in May, with a change to the greatest rainfall and lowest mean temperature recorded during the four years in the last week of May and three weeks in June. Both extreme drought and rain retarded the starting of the corn this year.

In 1890 and 1891 corn made almost exactly the same start each year. About the average amount of rain fell in April of each year and in May of 1890, but May, 1891, was rather dry, though apparently not dry enough to affect the corn that month. About the average mean temperature was also observed in April and May of these two years. Corn reached one foot in height two weeks after planting in 1892. The soil had been previously soaked with rain, but the seed and young plant had a much higher temperature in which to grow than had been the case in any other year, and there was very little rain for two weeks after planting. These seemed to be ideal conditions for the sprouting and early growth of this plant. The table shows, however, that when the corn was one foot high it contained less than 0.5 per cent of its total growth in dry matter, although it had attained 10 to 12 per cent of its total height.

Beginning when the plants were about one foot high, regardless of the date, and tracing their growth in both height and weight, each week of the seasons gives the following figures:

PERCENTAGE OF TOTAL GROWTH IN HEIGHT AND IN DRY MATTER IN THE CORN PLANT MADE EACH WEEK AFTER THE PLANT WAS 12 INCHES HIGH. RAINFALL AND MEAN DAILY TEMPERATURE FOR SAME PERIODS.

Week.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Percentage of growth in height.															
1889......	12.6	11.7	12.6	10.8	22.5	12.6	10	7.2	....	....	....	....	....	....	....
1890......	12	7.5	12.6	19.3	21.8	9.2	10.9	6.7	....	....	....	....	....	....	....
1891......	12	7	13	17	19	9	10	11	2	....	....	....	....	....	....
1892......	10	7	7	9	18	17	19	8	4	1	....	....	....	....	....
Average...	11.6	8.3	11.3	14	20.3	12	12.7	8.2	....	...	....	....	....	....	....
Percentage of increase in dry matter.															
1889......	.2	.5	2	3.5	10.4	10 5	7.5	15.3	8	3.5	19	0	7.2	12.2	....
1890......	....	.6	1.7	5.2	6.1	18.5	10.2	12	14.5	2	0	10.9	3.8	0	14.5
1891......	....	1.1	4.6	2.8	5.7	18.3	13.5	0	15.5	0	12	11	15.5	0	....
1892......	....	.4	.3	1.4	2.8	6.6	10	11.8	7	11.8	12.5	6.1	7	22.3	....
Average...	....	.6	2.1	3 2	6.2	13.5	10.3	10	11.2	4.3	11	7	8.4	8.6	....
Rainfall, inches.															
1889......	2.4	2.7	....	.06	2.3	.8	2.7	....	.6	....	....	1.3	....	....	1.4
1890......	1.1	.05	2.4	1.3	....	....	2.04	....	.8	.07	1.08	.4	.4	.3	....
1891......	....	.5	.23	1.02	.33	.07	.4	.13	.8	.01	1.35	1.28	.22	.35	....
1892......	.2	4.02	.86	1.32	.09	.8	.3	1.9	.4	....	.08	.2	.74	....	....
Mean daily temperature, F.															
1889......	62°	71°	67°	73°	75°	72°	71°	68°	69°	67°	71°	67°	70°	53°	56°
1890......	68	72	68	74	81	72	74	73	72	76	68	68	63	72	59
1891......	66	71	74	75	69	71	71	69	72	74	75	63	63	65	76
1892......	73	75	68	67	73	78	77	62	74	71	69	72	62	74	66

This shows that there was quite a uniformity in the proportional part of the total height attained each week during the years 1889, 1890,

1891. In 1892 a greater percentage of the growth was made later in the season than in the other years.

Comparing the growth in height in three years, 1889, 1890, and 1891, with the rainfall during the same time shows that in the second week of 1889 corn grew 4 per cent more in height than in 1890 and 1891 and that there was 2 in. more rain. No rain fell in the fourth week of 1889 and the plants were 6 and 8 per cent behind those of 1890 and 1891, which had over one inch rain that week. The record of the eighth week shows that the corn of 1891 made greater growth, but did not have much more rain than in the other two years.

The table also shows that the third week after the plants were one foot high in both 1889 and 1891 there was about the same growth in height and amount of rainfall, but the mean temperature for this week was 7 degrees higher, and there was double the increase of dry matter in the plants in 1891 as compared with 1889. In the fourth week the plants grew 10 in. more in height in 1890 than in 1892. There was about the same rainfall, but the mean temperature was 7 degrees higher in 1890 than in 1892. Other comparisons also show that the higher the temperature the better the corn growth, and that according to the observations made heat seemed to be more beneficial than rain. The most rapid growth in height was made when the corn was between 3 and 6 ft. tall. It grew 2 ft. per week for two weeks in succession the last of June, 1890. The excessive rain of April, May, and June, 1892, prevented the same growth of corn as in the previous years during these months, but about 3 in. in height per day was made in the last week in July, 1892. The table shows that in the first three years the corn reached its maximum height eight weeks after it was one foot high, but in 1892 it kept on increasing in height for ten weeks from this time.

No uniform relation between growth of plant and meteorological conditions can be exactly traced from these figures, which cover a period of four years of observations. One important reason for this is the fact already mentioned, that, unlike animals, plants cannot be weighed each week and then allowed to grow again. All these weights were necessarily made of different plants. The average figures show the general rate of growth in height and weight, and uniformly indicate that when a corn plant has reached its total growth in height it has attained only about one-half the weight of dry substance it will gain if left to grow to maturity.

COMPOSITION OF GREEN CORN PLANT.

The per cent of water and the composition of the fresh samples of corn cut weekly were determined only one year, but analyses were made of three samples taken weekly and the results doubtless represent the average composition of plants which are of the heights given, although they may attain these heights at different times in the different years.

This table is given especially to show the per cent of water in the plant from week to week. This changes from 90 to 55 from beginning to the end of the season, but, as before stated, it represents the general composition of corn plants of these heights rather than at the dates mentioned, because this particular season was about one month later in the spring.

ANALYSES OF GREEN CORN PLANTS.

Date when cut.	Average.		Chemical composition—percentages.					
	Height, n.	Weight, oz.	Water.	Ash.	Protein.	Fiber.	Starch, etc.	Ether extract.
June 10	2	....	81.6	....	....	....	....	....
" 17	12	....	85	....	....	....	....	....
" 24	23	.7	89.95	1.84	2.78	1.93	3.73	.54
July 1	28	1.1	88.86	1.48	2.69	2.37	3.9	.69
" 8	35	3.2	89.94	1.44	2.3	2.55	3.39	.37
" 15	48	8.2	91.64	.94	1.68	2.2	3.24	.29
" 22	67	12.1	86.82	1.12	1.29	3.76	5.55	.46
" 29	95	24.7	87.31	.93	1.54	3.66	6.09	.46
Aug. 5	100	29.4	82.76	1.13	1.85	5.14	8.55	.56
" 12	103	35.3	82.72	1.04	1.64	5	9.15	.43
" 19	111	41	80.78	1.13	1.73	5.34	10.54	.46
" 26	108	44	78.41	1.41	2.04	5.78	11.87	.47
Sept. 2	111	39.3	73.32	1.52	2.12	6.38	15.92	.73
" 9	107	41	71.65	1.63	2.48	6.49	17.01	.73
" 16	108	47	57.68	1.68	2.64	6.73	20.32	.93
" 23	105	41	63.72	1.77	2.81	7	23.57	1.11
" 30	110	37	59.96	1.88	2.7	8.37	25.93	1.15
Oct. 7	107	33	56.02	1.85	3.51	9.1	28.17	1.34

This table shows that the plants reached their total growth in height August 19th. There was an increase in the weight of water in the plant every week up to August 26th, when it reached its maximum, and then gradually decreased as the plant dried. The growth of the plant did not cease, however, at the time it stopped growing in height, or when it had accumulated the greatest weight of water. The gain of dry matter continued every week up to September 16th, four weeks after reaching its greatest height. The weight of dry matter in the plant after September 16th remained about the same up to October 7th. The slight difference is probably caused by loss of dried portions of the plant which may have been blown away by the wind.

The increase in weight of the ash, protein, etc., of the plant all followed the same course of the dry matter. They increased in amount up to the last of September. When the plant had reached its greatest height, 9 ft: 3 in., it contained 33 oz. water and 7.8 oz. dry matter. This dry matter contained about ½ oz. ash, ¾ oz. protein, 2¼ oz. fiber, 4¼ oz. nitrogen-free extract, and 1-5 oz. ether extract. After this time the plant continued to grow in weight until its maximum weight of dry matter was 15 oz., containing ash, 1 oz.; protein, 1½ oz.; fiber, 3 oz.; nitrogen-free extract, 9½ oz.; and ether extract, ¼ oz.

The analysis of the fresh samples shows that a given quantity (100 lb.) of young corn plants 2 ft. high contained as much protein and ash as the same quantity of fully mature corn, although the young corn plant has 90 and the ripe plant only 60 per cent of water. This does not hold true of the other constituents, however. The fiber, starch, etc., in 100 lb. of the ripe plant is nearly 10 times that in the young corn. The relation between the nitrogenous (protein) and carbonaceous (fiber, starch, etc.) constituents is as 1 to 3 in the young plant and as 1 to 13 in the ripe corn plant in September and October.

100 lb. corn 2 ft. high contained 1.8 lb. ash, 2.8 lb. nitrogenous matter, 6.2 lb. carbonaceous, and 89.2 lb. water.

100 lb. ripe corn 9 ft. high contained 1.8 lb. ash, 2.8 lb. nitrogenous matter, 35.4 lb. carbonaceous, and 60 lb. water.

LENGTH OF THE GROWING SEASON.

The five months from May to September, inclusive, comprise the corn growing season. Some changes probably occur in the plant after September in certain seasons, but as a rule, corn gets its growth by the first of October. The temperature and rainfall in April have considerable influence on the time of planting corn in the spring, hence the consideration of the April weather is important when comparisons are made of the corn growth in different years.

In 1889, 1890, and 1891 it was four and one-half months from the time the corn was planted until the plant had reached its maximum weight of dry substance. The heavy rains in April and May of 1892 made the corn growing season of that year one month shorter than in the three previous years. The plants attained their weight of dry matter by the middle of September, as in the previous years. A comparison of the different years shows that corn was planted, reached its maximum height and gross weight of dry substance per plant at the following dates:

	1889.	1890.	1891.	1892.
Planted...	May 4.	May 5.	May 9.	June 3.
Tallest....	Aug. 5-111 in	July 22–119 in	July 28–98 in.	Aug. 19-100 in.
Heaviest..	Sept. 16–13.8 oz.	Sept. 9–14.8 oz.	Sept. 2–12.3 oz.	Sept. 16–14.8 oz.

Analyses of the corn plants were made up to the first week in October, but, from loss of leaves which dried and broke off, there was not so much dry matter in the plants as was found about the middle of September. There may be changes going on in the plant after this date, but during these four years no further increase in weight was observed.

COMPOSITION OF THE DRY MATTER OF THE CORN PLANT.

The average maximum weight of dry matter per corn plant and dates when this was reached each year were as follows, 1889, 14 oz., third week in September; 1890, 15 oz., second week in September; 1891, 12.5 oz., first week in September; 1892, 15 oz., third week in September; average 14 oz.

The composition of this dry matter as found by analyses made in the three years 1890, 1891, and 1892 was as follows:

Composition of maximum Weight of Dry Matter, Percentages.

	Ash.	Protein.	Fiber.	Nitrogen-free extract.	Ether extract.
1890	5.3	7.3	19.9	64.9	2.5
1891	5.1	8.5	21.7	61.7	2.9
1892	5.2	8.2	20.8	62.8	2.9
Average	5.2	8	20.8	63.2	2.8

Assuming that there are 10,000 plants per acre, these analyses show that an acre of such corn, grown to maturity would contain about 8,750 lb. dry substance, composed of 455 lb. ash, 700 lb. protein and 7,595 lb. carbohydrates, including fiber, starch, sugar, etc.

When the plants were about 18 in. high, their water free substance contained about 17 per cent mineral matter, 27 per cent protein, 35 per cent nitrogen-free extract, and 20 per cent fiber. As the plant matured the percentages of ash and protein decreased, and the fiber, starch, sugar, gums, etc., increased. This change was most marked from the time when plants were a foot high until they reached the roasting ear stage, when the water free substance of the plant contained about 6 per cent mineral matter, 9 per cent protein, 58 per cent nitrogen-free extract, and 25 per cent fiber. After this time there was not so great a change in the proportion of these constituents.

The analyses of the corn plants through the three years show the same kind of a change each year in the composition of the dry matter of the plant at the same stage of its growth. All the analyses were made of the whole corn plant. No attempt was made to separate the ear, stalk and leaves, but the whole plant was chopped fine and the mixture analyzed.

Composition of different Parts of the Corn Plant—Percentages.

	Water.	Ash.	Protein.	Fiber.	Nitrog'n free extract.	Ether extract.
Ears fresh	42.81	.99	3.51	5.15	45.1	2.44
Water-free		1.74	6.13	9.01	78.86	4.26
Stalks fresh	74.45	.84	.62	8.84	14.82	.43
Water-free		3.27	2.41	34.62	58.03	1.67
Leaves and husks fresh	57.89	4.4	1.93	12.47	22.24	1.07
Water-free		10.45	4.59	29.62	52.8	2.54

The composition of the different parts of the plant, when the husks were dry and the kernels could be indented by the thumb nail with difficulty, is shown by the foregoing figures taken from Bulletin No. 4, p. 91 of this Station—variety, Burr's white.

LOSS OF DRY MATTER BY SPROUTING OF CORN SEEDS.

When seeds sprout, a certain amount of their own substance is necessarily used to sustain the developing life until the plant can assimilate from other sources the necessary material for growth.

The following experiment was made to trace the gain and loss of material that occurred in the first stages of development of the corn plant.

April, 1892, the amount of water and dry matter was determined in a sample of seed corn. These results were used for estimating the weight of water and dry matter in the kernels which were taken from the same sample and sprouted. The first trial was made by placing six kernels in damp cotton where they were left to sprout in the dark for nine days. Four of these kernels partly sprouted, then moulded, failing to develop further. An analysis showed that they lost in this partial sprouting process 9 to 18 per cent of the dry matter in the original seed. Each one of the four was analyzed separately, and the adhering shell of the kernel was included in the estimated dry matter.

Two of the six kernels sprouted and developed a corn plant. The root and stem of these plants each measured two to three inches, and their weight was from three to three and one-half times that of the original kernel. It was found, however, that when the water was dried out of these young plants the dry matter in them was 20 to 31 per cent less than the seed contained.

DETAILS OF WEIGHTS IN GRAMS.

	Dry matter.	Water.	Total.
Weight of seed before sprouting...........	0.271	0.042	0.313
Plant with seed attached after 9 days sprouting in damp cotton..................	0.187	0.747	0.934
Gain or loss of plant over seed............	—0.084	+0.705	+0.621
Per cent gain and loss was of weight in seed	—31	+1680	+198
Duplicate trial gave......................	—19.80	+1945	+239

This shows that in sprouting the white plant had taken up a large amount of water but lost about one-fourth of the dry matter in the seed.

This experiment was repeated June 3, 1892, by sprouting the seed in the soil of a corn field instead of in cotton. Each kernel planted was weighed and the young plants dug up, weighed, and measured. The details of these weights are given in the table.

COMPARISON OF DRY MATTER IN SEED AND IN YOUNG PLANT.

Plant No.	Weight in grams.			Measurement of plant, in.			Dry matter.	
	Seed.		Green Plant.	Tip of leaf to seed.	Above ground.	Roots.	In plant, grams.	Per cent of that in seed.
	Dry matter.	Total.						
Plant and root, one week from planting.								
1	.416	.479	1.64	4	2	5	.331	79
2	.357	.412	1.45	4½	2	5	.210	59
3	.347	.450	1.55	3½	2	4	.273	78
4	.393	.457	1.45	1½	3½	4	.310	78
Plant above ground, two weeks from planting.								
5	.378	.437	3.23	.....	14	......	.493	130.4
6	.346	.4	1.79	......	9½	......	.3	86.7
7	.395	.456	2.47	......	11½	......	.435	110.1
8	.404	.466	2.61	......	11	......	.348	86.1
9	.424	.49	3.54	......	12	......	.437	103
Plant above ground, three weeks from planting.								
10	.348	.402	16.6	......	21½	......	1.82	524.6
11	.413	.477	18.6		20½	......	2.04	495.4

One week after planting the plants were dug up. They were from one to four inches above ground and each had two green leaves. The shell of the kernel still clung to the plant. The root was about 5 in. long, making a total length of about 10 in. from tip of leaf to end of root. The weight of these green plants (leaf and root) was about four times that of the seed planted, but when the water was dried out they contained less dry matter than the seed, from 58 to 79 per cent only of that in the original seed.

Two weeks after the seed was planted, five plants were cut at the surface of the soil and the weights and measurements of each plant above ground were compared with the weight of its seed.

The table shows that these corn plants, having a height of 10 to 14 in. above ground, weighed when fresh 4 to 8 times as much as their seed, but that this increase of weight came almost entirely from the water absorbed. The dry matter in some of these plants was less than that in the kernels planted.

The table also shows that a plant 20 inches high weighed over forty times as much as the seed but contained only about five times as much dry matter.

E. H. FARRINGTON, M. S., Chemist.

EXPERIMENTS WITH OATS, 1893.

This article reports results of the following experiments with oats conducted in 1893:

No. 12. Oats, quantity of seed per acre.
No. 14. Oats, time of sowing.
No. 15. Oats, depth of sowing.
No. 128. Oats, effect of time and manner of harvesting upon yield and chemical composition.

SUMMARY.

The trials were all made on the fertile, dark colored prairie soil of the Station grounds. The rainfall during April and May was large; in June, unusually small. For July the rainfall was .59 inches and the average temperature 74.6° F.

RAINFALL AND TEMPERATURE.

	1889.		1890.		1891.		1892.		1893.	
	Rain, in.	Temperature.	Rain, in.	Temperature.	Rain, in.	Temperature,	Rain, in.	Temperature.	Rain, in.	Temperature.
April........	0.61	52°	4.11	52.3°	3.54	52.8°	6.45	48.6°	7.68	49.3°
May........	5.52	59.2	3.56	58.3	0.89	58.4	7.86	57.9	4.83	57.4
June........	6.81	65.5	3.8	74.6	2.08	72	5.36	70.6	1.55	70.5
	12.94		11.47		6.51		19.67		14.06	

Unforeseen circumstances affected the tests made with a large number of varieties to such an extent that it was thought that the results might be misleading rather than helpful, and they are not reported. In no other case did the experiments in the year 1893 materially modify the results obtained in former years, and the general suggested conclusions concerning oat culture may be restated in the following extract from bulletin No. 23, the only change being in the number of years the experiments have continued:

"The results of all the experiments with oats tried at this Station for the last six years suggest that on the fertile soil of central eastern Illinois, with simple methods, we may expect in a series of years an average yield an acre of a little over 50 bushels of grain and about one and one-half tons of straw, the oats weighing rather less than more than the standard weight of 32 lb. a bushel; that it is not advisable to plow the land in the spring if the crop follows corn, the use of the disk har row giving better results; that the seed should be sown near the last of March or first of April; that if sown broadcast it is better to sow from two and one-half to three and one-half bushels per acre, covering the seed not more than one or two inches deep; that there is no one variety greatly superior to all others, so that it is not wise to put full credence in the claims often made for new varieties; that some varieties are, however, distinctly better than some others; that neither color nor plumpness of kernels, weight per bushel, nor the form of the head certainly determines value; but that, generally, varieties with long, slender, comparatively light kernels have the smallest percentage of husk and, probably, the greatest feeding value; that early maturing varieties are to be preferred to those ripening later; that it is desirable to harvest the crop before it has fully ripened; and that binding and shocking the sheaves at once is an advantage rather than a disadvantage, if the grain is in fit condition for cutting."

Experiment No. 12. Oats, Quantity of Seed per Acre.

The land used for this experiment was in corn in 1892, and the stalks had been removed. April 3, 1893, a series of seven plats, each one-fortieth of an acre, was sown broadcast with Pringle's progress oats, at the varying rates of 1, 1.5, 2, 2.5, 3, 3.5, and 4 bu. (32 lb.) per acre. The plats were disked twice with a light two-horse disk before sowing, and twice after, then harrowed once lightly, seeded with clover and timothy and again harrowed.

Slightly the largest yield of grain was from sowing 2½ bu. Contrary to the usual results, the yield from sowing one bu. was nearly as large. The largest yield of straw was from sowing 3 bu., but with little variation from sowing 2½, 3, or 3½ bu. The yield of straw was the largest from sowing 2½ bu.

The average of the results from six years' trials show largest yield from sowing 2½ bu., with nearly as large from sowing 3 bu., and no important difference in yield whether 2½, 3, 3½ or 4 bu. were sown. The average yield of straw was slightly largest from sowing 3 bu. per acre. The yields of both grain and straw varied greatly in the different years, but the average is satisfactory—over 50 bushels of grain and not far from 3,000 lb. straw per acre.

Experiment No. 14. Oats, Time of Sowing.

The land used for this experiment was in corn in 1892, and the stalks were removed.

March 31st, the land was disked and staked out in 12 plats, each one-twentieth of an acre in area. Plats 1 to 6, inclusive, were sown each with four pounds, and the remaining six each with five pounds of oats. The oats, Pringle's progress, were sown broadcast by hand and covered by disking. The plats were then harrowed, sown with timothy

YIELD OF OATS FROM DIFFERENT RATES OF SEEDING, 1893.

Plat No.	Seed per acre, bu.	Stubs per sq. ft.	Wt. 100 berries, grams.	Per cent kernel in berries.	Pounds per bu.	Yield per acre.	
						Straw, lb.	Grain, bu.
1	1	19	2.17	73.2	36.5	2330	62.2
2	1.5	21	1.79	76	38	2190	52.8
3	2	41	2.25	70.4	38.25	2110	54.1
4	2.5	33	2.10	74.3	34	2630	62.8
5	3	40	2.07	77	36	2580	55.6
6	3.5	47	2.13	67	37	2080	50
7	4	47	2	72.2	33.75	2395	55.8

YIELD OF OATS FROM DIFFERENT RATES OF SEEDING, 1888 to 1893.

Seed per acre, bu.	1888.	1889.	1890.	1891.	1892.	1893.	Average.
Straw per acre, pounds.							
1	3820	4600	2820	1275	1742	2330	2764
1.5	4400	3800	1740	1970	1980	2190	2680
2	4540	4000	1800	2748	1832	2110	2838
2.5	4860	3000	2460	2638	1935	2630	2920
3	5220	4400	1960	2790	2100	2580	3192
3.5	4400	4100	2000	3060	1952	2080	2932
4	4260	3200	2020	3110	2377	2395	2894
Grain per acre, bushels.							
1	52.5	36.3	25.3	36.7	40.5	62.2	42.2
1.5	59.4	33.1	21.6	56.9	43.5	52.8	44.5
2	61.4	42.5	17.5	74.8	43.3	54.1	48.9
2.5	63.8	43.8	29.1	72.6	44.5	62.8	52.8
3	61.9	47.2	27.5	76.6	44.3	55.6	52.2
3.5	62.5	52.1	24.7	79.7	42.4	50	51.9
4	60.6	50.6	21.9	76.3	43.2	55.8	51.4
Pounds per bushel.							
1	....	25.5	26	28.5	25.5	36.5	28.4
1.5	....	25	26.5	31	27.5	38	29.6
2	....	28	24	31.5	28	38.25	30
2.5	....	28	29	32	28	34	30.2
3	....	29	29	32.5	28	36	30.9
3.5	....	29.5	28	32	28.7	37	31
4	....	29.5	29	32	29.2	33.75	30.7

and clover, and again harrowed. The following table gives the dates of sowing and ripening, yield of both straw and grain, pounds per bushel, and per cent of kernel in berries for each plat, also the average for each sown at the same date. A mistake made in harvesting prevents giving the separate yields of plats 2 and 3.

In general, the yield of both straw and grain, pounds per bushel and per cent of kernel decrease with the lateness of sowing.

The second table, giving the average for five years, shows the largest yields to be from the earlier sowings, with quite a uniform decrease in yield as the season advances.

YIELD OF OATS FROM SOWING AT DIFFERENT TIMES, 1893.

Date of sowing.	Ripe July	Plat No.	Yield per acre.		Lb. per bu.	Per cent kernel in berries.	Plat No.	Yield per acre.		Lb. per bu.	Per cent kernel in berries.	Average.			
			Straw, lb.	Grain, bu.				Straw, lb.	Grain, bu.			Yield per acre. Straw, lb.	Yield per acre. Grain, bu.	Lb. per bu.	Per cent kernel in berries.
Mar. 31	18	1	2040	51.3	35	73	7	2235	58.9	34	75	2137	55.1	34.5	74
Apr. 8	19	2	1930	49.7	34	72	8	2225	56.7	35	73	2077	53.2	34.5	72.5
" 17	20	3					9	1680	38.8	33	66	1805	44.2	33.5	69
May 3	26	4	2155	46.4	28.5	70	10	1490	27.2	30	72	1822	36.8	29.3	71
" 3	26	5	1555	27.7	30	69	11	1410	24.7	30	64	1482	26.2	30	66.5
" 10	28	6	1280	15	27	66	12	1355	15.2	27	57	1317	15.1	27	61.5

YIELD OF OATS FROM SOWING AT DIFFERENT TIMES, 1888—1893.

Date of sowing.	1888		1889			1890			1892			1893			Average.		
	Yield per acre. Straw, lb.	Yield per acre. Grain, bu.	Lb. per bu.	Yield per acre. Straw, lb.	Yield per acre. Grain, bu.	Lb. per bu.	Yield per acre. Straw, lb.	Yield per acre. Grain, bu.	Lb. per bu.	Yield per acre. Straw, lb.	Yield per acre. Grain, bu.	Lb. per bu.	Yield per acre. Straw, lb.	Yield per acre. Grain, bu.	Lb. per bu.	Yield per acre. Straw, lb.	Yield per acre. Grain, bu.
Mar. 14	....	....	28.5	3600	48.1	....	....	....	....	....	....	....	....	....	....	....	....
" 22	....	....	28	4600	41.5	31.8	3140	44.1	....	....	....	....	....	....	29 9	3870	42.8
Mar. 28-31	....	....	28.5	5200	41 3	31	3390	45.1	28	1767	46	34 6	2137	55.1	30.5	3124	46.8
Apr. 4-8	5080	66.3	26.5	4000	36.3	27	2890	36.5	27.5	1520	42 4	34.5	2077	53.2	28.8	3113	47
Apr. 11-17	5020	56.5	25	4000	33.1	27.3	3020	30	26.5	1442	47.7	33 4	1805	44.2	28	3057	42.3
Apr. 18-21	5040	48.8	22	4100	25	26.8	2740	28.1	25	1332	41.7	....	....	....	24.7	3303	35.9
Apr. 25-28	5020	49,4	21	3700	9.4	26.8	2540	19.6	15	1482	42.4	....	....	....	20.9	3186	30.2
May 3-4	....	....	....	....	....	....	....	....	19	1325	23.9	29.6	1652	31.5	24.2	1489	27.7
May 10	....	....	....	....	....	....	....	....	....	....	....	27	1317	15.1	....	....	....

Experiment No. 15. Oats, Depth of Sowing.

April 6, 1893, sixty selected kernels were planted in each of twelve rows 10 ft. long. Rows 1 and 2 were covered one inch deep, and each succeeding two rows one inch deeper, rows 11 and 12 being covered six inches deep. There was an extra row on either side. The table gives the number of plants started, number of panicles harvested, weight of grain, and weight of 100 kernels for each row. In general there is a decrease from the shallowest to the deepest planting.

YIELD OF OATS FROM SOWING AT DIFFERENT DEPTHS, 1893.

Depth sowing, inches.	Row No.	No. panicles harvested.	Wt. straw, ounces.	Wt. grain, ounces.	Wt. 100 kernels, grams.
1	1	175	13.25	7.75	2.14
1	2	196	15.75	8.5	2.27
2	3	165	13.5	8	2.3
2	4	133	10	5.75	2.28
3	5	110	8.5	4.5	2.17
3	6	133	10.5	5.5	2.32
4	7	142	11	6	2.25
4	8	154	11.5	6	2.07
5	9	91	9.25	4	2.2
5	10	56	5	2.25	2.04
6	11	13	.75	.25	1.89
6	12	21	1.5	.75	

YIELD OF OATS FROM SOWING AT DIFFERENT DEPTHS, 1888 to 1893.

Depth of sowing, inches.	1888		1889		1890		1891		1892		1893		Average.	
	No. of panicles.	Relative yield.	No. of panicles.	Relative yield.	No. of panicles.	Relative yield.	No. of panicles.	Relative yield.	No. of panicles.	Relative yield.	No. of panicles.	Relative yield.	No. of panicles.	Relative yield.
1	566	90	407	81	362	100	205	69	179.5	100	185.5	100	318	90
2	495	80	424	69	312	76	338	100	161	94	149	85	313	84
3	465	100	434	76	307	65	192	49	146.5	85	121.5	62	278	73
4	469	95	439	100	269	65	188	55	171.5	77	148	74	281	78
5	481	80	....	....	181	29	136	26	177.5	51	73.5	38	210	45
6	445	55	....	....	75	12	91	18	155.5	63	17	6	157	31

The foregoing table giving results for each of six years shows the average relative yield to be in favor of covering one inch deep, with a decrease in yield for each succeeding inch, excepting four inches deep.

Experiment 128. Oats, Time and Manner of Harvesting. Effect upon Yield and Chemical Composition.

[The first paragraph and table following are from Bulletin No. 23.]

"For each of the years 1891 and 1892, trials were made to determine the effect of time and manner of harvesting oats. In the table is given for each year the average results from six plats harvested early, six when medium ripe, six when fully ripe, and of six plats which were bound and shocked soon after cutting, six cut and allowed to dry thoroughly in the swath before being bound, and of six where the heads were cut off, leaving most of the stalk standing. There are no very striking differences shown, except in the case of the plats cut late in 1892. This result was in part due to the fact that some of these plats were not so favorably situated as some of the others in the experiment. In each year the best results were obtained where the sheaves were bound and shocked soon after cutting. The explanation is not readily given, but the facts seem to show that this ordinary practice is a good one. Striking differences in the yield in the two years are shown, and equally striking differences in the weight per bushel. The variety was not the same. In 1891, welcome oats were used; in 1892, Pringle's progress."

EFFECT OF TIME AND MANNER OF HARVESTING OATS AT DATES AND UNDER CONDITIONS GIVEN.

Date.	Stage of Ripeness.	Yield per acre.		Pounds per bu.	Wt. 100 berries.	Per cent kernel in berries.
		Straw, lb.	Grain, bu.			
1891, July 6.	Stems green, ½ leaves green, kernels mostly in milk....................	2887	64.4	34	2.31	69.8
" 11.	Kernels mostly in dough, some hard..	2619	63.9	34.7	2.43	71.3
" 17.	Fully ripe.........................	2179	59.4	34.5	2.46	71.2
....	Bound and shocked in ordinary manner....	3180	63.1	34	2.46	70.8
....	Loose till dry, then bound and shock'd	3179	56.5	34.7	2.38	71.7
....	Heads removed.....................	1307	65.4	34.5	2.39	69.8
1892. July 16.	Stems green, ¼ leaves green, kernels mostly in dough, some in milk.....	1656	45.1	26.25	2.31	67.58
" 22.	Oats mostly hard, some in dough.....	1740	45.9	25.7	2.22	66.7
" 30.	Fully ripe.........................	1284	33	25.4	2.25	66
....	Bound and shocked in ordinary manner............................	1892	45.5	26.5	2.27	67.6
....	Loose till dry, then bound and shock'd	1770	42.8	25.9	2.27	66
....	Heads removed.....................	1020	35.6	25.9	2.22	66.6

EFFECT UPON CHEMICAL COMPOSITION.

In addition to the above a chemical analysis was made of the grain of each of the plats for each year, also an analysis of the straw for each for 1892, and an analysis of the stubble from the plats that were headed. Duplicate analyses were made for each plat and the average taken. The tables give the average composition of six plats cut early, six plats cut medium ripe, six plats cut fully ripe, and six plats which were bound and shocked soon after cutting, six cut and allowed to dry in the swath before binding and shocking, and six having the heads removed leaving most of the straw standing; also the average of three plats of stubble. For 1891, there seems to be no difference in composition worthy of mention, due either to time or manner of harvesting. In 1892, the protein and fat are slightly higher for the early curing and for those bound and shocked. As to the straw, it also shows a higher per cent of protein and fat for the earlier cutting than for either the medium or late. As to manner of harvesting, the small quantity of straw from the plats that were headed was slightly better, while the stubble from the same plats was slightly poorer in protein than was the straw from the plats harvested by other methods.

There is quite a difference in the composition of the grain for the two years. That for 1891 has considerably the higher per cent of fat and protein, and consequently a higher feeding value. This better composition of the oats of 1891 may be due to the fact that it was the more favorable season for oats, or that they were of a different variety. It suggests that it might be profitable to study more carefully the composition of different varieties as grown under different conditions.

Analyses of Grain, Straw, and Stubble of Oats harvested at different Stages of Ripening, 1891–2.

Analyses of Grain, 1891.

	Ash.	Protein.	Fiber.	Nitrogen-free extract.	Ether, extract.
July 6. Stems green, ½ leaves green, kernels mostly in milk	3.40	14.94	12.52	62.95	6.20
July 11. Kernels mostly in dough; some hard	3.41	15.01	11.95	63.73	5.90
July 17. Fully ripe	3.36	15.25	12 06	63.40	5.93
Bound and shocked in ordinary manner	3.45	15	12.54	63	6.03
Loose till dry, then bound and shocked	3.35	15.15	11.93	63.71	5.86
Heads removed	3.39	15.05	12.05	63.38	6.13

Analyses of Grain, 1892.

	Ash.	Protein.	Fiber.	Nitrogen-free extract.	Ether, extract.
July 16. Stems green, ¼ leaves green, kernels mostly in dough; some in milk	3.51	13.30	12.79	65.73	4.66
July 22. Oats mostly hard, some in dough	3.75	13.22	12.58	66.37	4.08
July 30. Fully ripe	3.81	12.56	13.09	66	4.54
Bound and shocked in ordinary manner	3.73	13.24	12.60	66.38	4.05
Loose till dry, then bound and shocked	3.64	12.80	13.05	65.86	4.65
Heads removed	3.69	13.05	12.81	65.81	4.58

Analyses of Straw, 1892.

	Ash.	Protein.	Fiber.	Nitrogen-free extract.	Ether, extract.
July 16. Stems green, ¼ leaves green, kernels mostly in dough, some in milk	8.93	4.05	42.14	42.80	2.07
July 22. Oats mostly hard, some in dough	8.66	3.69	44.75	40.85	2.04
July 30. Fully ripe	7.79	3.93	45.58	40.99	1.71
Bound and shocked in ordinary manner	8.93	3.77	44.46	40.79	2.05
Loose till dry, then bound and shocked	8.27	3.66	44.31	41.81	1.94
Heads removed	8.37	4.22	43.50	42.02	1.89
Analysis of stubble, 1892, av. 3 plats	8.77	3.58	45.64	39.86	2.15

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UNIVERSITY OF ILLINOIS.
Agricultural Experiment Station.
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BULLETIN NO. 32.

AN ACID TEST OF CREAM.

The sourness of cream is one of the things considered by many dairymen in making butter. They may not agree on the amount of acidity that cream should have when it is ready for churning, but many base their judgment on the taste or appearance of the cream.

The first record of a measurement of the acidity of cream before churning, so far as known to the writer, was reported in 1887 by John Sebelein, in Versuchs-Stationen, XXXIV, p. 94. He used an alkaline liquid of known strength (one-tenth normal) and by adding a few drops of a liquid indicator, phenolphtalein, to a measured quantity of cream (50 c. c., or about one-tenth of a pint) the amount of acid in the cream was estimated by measuring the quantity of the alkaline liquid that it was necessary to add to the 50 c. c. of cream in order to produce a pink color in the cream tested. The indicator, phenolphtalein, has the property of causing a pink color in some alkaline liquids, but does not change the color of acid solutions. This gives a means of measuring the amount of acid in milk or cream by noting the quantity of an alkaline liquid of known strength that will produce this pink color in a measured amount of cream. The strength of the alkaline liquid and the amount of cream taken for each test are constant, known quantities, always the same in comparative trials of different lots of cream. The amount of acid in the measured quantity of cream is unknown until, by testing, it is observed how much of the standard alkaline liquid it is necessary to use to produce the pink color. A one-tenth normal solution of an alkali is of a definite strength understood by chemists. The alkali may be caustic soda, potash, lime, or baryta. All these are efficient and results will be comparable, if a one-tenth normal solution of any one of them is used.

In the fall of 1889 this method of testing the acidity of cream was used by Dr. Manns, at the creamery of Gurler Bros., DeKalb, Ill., and also in churnings of cream which he made at this Station. He found that when cream was churned at a temprature of 58° to 62° F. too much acid in the cream injured the quality of the butter, and too sweet cream churned at this temperature caused a loss of butter in the butter milk. The butter was not all churned out unless the cream was sufficiently soured. The butter was of poor quality if the cream was too sour. These trials indicated that, so far as the acidity of the cream had an influence on the flavor of the butter and on the thoroughness of the churning at 58° to 62°, the best results were obtained when the acidity of 50 c. c. of cream was neutralized by about 40 c. c. of one-tenth normal alkali. This work was published in bulletin No. 9, of this Station, May, 1890. The "per cent of acidity" as given in that bulletin can be converted into c. c. of one-tenth normal alkali by multiplying the "per cent of acidity" by 5,000 and dividing by 87.

A Chicago dealer in dairy supplies put on the market the necessary outfit for testing the acidity of cream by the method already described, under the name of "Manns acid test." The apparatus is sold for $5.00 and the "neutralizer," or one-tenth normal alkaline liquid, at $1.00 per gallon. This amount of the liquid ought to make about 100 tests of cream. The liquid itself is not expensive, but its exact strength must be accurately determined by a person who has the necessary apparatus for testing it. In order to use this test it is also necessary to have a burette for measuring the alkaline liquid, a pipette for measuring the cream, and an alcoholic solution of phenolphtalein. The necessary manipulations in using the test are simple and the method has given good satisfaction to the writer and others in practical dairy work. The same amount of acidity in cream may not be universally adopted, but no one wants cream to sour until it spoils the flavor of the butter.

This acid test of cream has been extensively used by Gurler Bros., and at other places. Since it was first introduced, Mr. H. B. Gurler observed that the exhaustiveness of churning, or the complete separation of all the butter from the cream by churning, was largely influenced by the temperature at which cream was churned rather than by the acidity of the cream. The practice in his creameries during the past year or more has been to churn thick separator cream, contained 25 to 35 per cent of fat, at a temperature of 45° to 55° F., usually about 52° F. This is the temperature of the buttermilk when drawn from the churn immediately after the butter "comes," and not always the temperature of the cream when it is put into the churn. If the churning is done in a warm or cold room the temperature of the cream will gradually attain the temperature of this room, although it may have been warmer or cooler than the room when it was put into the churn, so that the temperature of each churning is the temperature at which the butter comes.

When cream is obtained by the gravity processes of setting milk, it does not often contain much over 15 per cent of fat. Such cream is ordinarily too thin to be churned at this low temperature, but must be ripened and churned at about 62° F. The best separators, however, can be so regulated as to give cream of a desired thickness and at the same time skim the milk so thoroughly that only a trace of fat is left in the skim milk.

It has been found by Mr. Gurler in his practice and by observations made by the writer at his creameries, that thick cream containing about 30 per cent fat can be churned at about 52° F., so that there is only a trace of fat left in the buttermilk. This shows that under proper conditions the churn can be made to do as efficient work as the separator, and that within certain limits, the thickness of the cream and the temperature at which it is churned have more influence on the exhaustiveness of churning than does the acidity or sourness of the cream, Although this is true, an acid test of cream can be of great practical value especially for the purpose of indicating the proper degree of ripeness of cream to be churned; for if cream continues to ripen after it has reached a certain amount of acidity, another kind of fermentation seems to take place which injures the quality of the butter.

The fermentation or souring of cream is caused by bacteria. These are plants which are seen only by the aid of a powerful microscope. They multiply amazingly fast when kept at the proper temperature. Among plants which we can see without any microscope there are certain varieties which we call weeds. If weed seeds are in the soil they grow as well as the good seed which we plant. The same thing is true of the microscopic plants, bacteria. There are some which we are as anxious to keep out of cream as we are to prevent the growth of weeds in a corn field, and there are others which at present are considered to be the agents in producing a fine flavor in butter.

Dirt is the source of most all "bad" bacteria which find their way into milk, cream, and butter. If everything was clean through which the milk passes, from cow to caddy of butter, it would be a comparatively easy matter to plant a pure culture of bacteria in cream, and get that ferment alone, or in large excess over all others; but, like weed seeds in soil, we have to contend with bad bacteria, which grow up and choke the good seed and all the superior qualities thereof.

If great care were taken to keep the cows clean, the milker clean, and the milk dishes clean, there would be a greater certainty of producing a high flavored and high priced butter, because there are fewer weed seed bacteria in clean milk and cream.

The rate at which cream ripens in ordinary practice is not often uniform. It is not only influenced by the cleanliness of the milker and dairyman, as mentioned above; but the weather, the temperature at which the cream is set for ripening, and the amount of fat in the cream also influence the rapidity of souring. Hot or warm, muggy weather has a tendency to hasten souring, while a clear, bright atmosphere, as well as cold, are not so favorable for the growth of the bacteria which cause cream to sour.

Since it is the milk sugar that ferments when cream sours, it is obvious that thin cream, with only ten to fifteen per cent of fat, contains more milk sugar and will sour faster than rich cream which contains more fat and consequently less milk sugar and casein.

These uncertain quantities, cleanliness, weather, and richness of the cream, which all have an influence on the rate at which cream sours, show the value of some simple test to indicate the amount of acidity in cream for churning; for, as said above, after cream has soured to a certain point, another kind of fermentation takes place that injures the quality of the butter.

A simple test that will indicate the amount of acid in cream can be used to show when cream is sour enough to suit the standard adopted by different men and markets. A uniformity in the sourness can thus be obtained by churning each lot of cream when the test shows a certain amount of acidity, and no lot of cream need spoil from over ripeness, as the test will show when the danger point is near.

In following up this line of work the writer has developed a method of

CREAM TESTING WITH ALKALINE TABLETS.

A formula has been worked out by which a definite amount of solid alkali can be made into a tablet containing both the alkali and the indicator necessary for testing the acidity of cream or milk.

Each tablet contains a definite amount of alkali which will neutralize as much acid as 4.66 c. c. of a one-tenth normal alkaline liquid. A test of a number of the tablets showed them to be very uniform in the amount of alkali contained in each tablet. The extreme difference amounted to three-tenths of one c. c. of the one-tenth normal liquid. One thousand tablets weigh about twelve ounces. Each tablet is about three-eighths of an inch in diameter and one-eighth inch thick, and they can be used instead of the one-tenth normal alkaline liquid and the liquid indicator mentioned on page 390.

The tablets can be used for testing the acidity of cream in the following way:

DISSOLVING THE TABLETS.

Label several clean 4 or 6 oz. white glass bottles, No. 1, No. 2, No. 3, etc. Put one tablet into each of the bottles numbered 1; two into each numbered 2; and three into each bottle numbered 3, etc.

The bottles can be labeled by roughening a place on the side of the bottle with a wet file. The number can be marked with a lead pencil on this rough surface.

Add to each bottle enough clean, soft water to completely cover the tablets and let them stand until the tablets are all dissolved. They will dissolve faster in hot than in cold water. If the solution of the tablets is hastened by shaking the bottle or stirring the liquid, it should be done in such a way as to prevent any loss. As they do not dissolve immediately they should be put to soak about one-half hour before the cream is to be tested. The strength of the solution does not change perceptibly by standing four or five hours, but there is some change in a tablet solution which is a day or more old. The solid tablet will not change, and the only precaution necessary is to use a fresh solution of the tablets in testing the acidity of cream. Excepting the flocculent residue or settlings, which will not dissolve in water, the tablets should all disappear in the solution before it is added to the cream to be tested. When the solution is complete the bottles contain a reddish colored liquid, the alkaline strength of which is indicated by the number on the label of the bottle that shows how many tablets were put into each bottle.

Testing the Cream.

The cream to be tested should be thoroughly mixed. Then measure 25 c. c. of the cream into a glass tumbler or a cup. If the cream is very thick, 25 c. c. of clean rain water may be mixed with it in the dish. The sourness of the cream is then ascertained by adding the reddish colored solution of the tablets to this measured quantity of cream until it retains a pinkish color. When the two liquids, cream and tablet solution, are thoroughly mixed, the pink color does not remain permanent until the acid of the cream is completely neutralized by the alkali of the tablets. An excess of the alkali causes the color to increase. The acidity of the cream is measured by adding just enough of the alkali to produce a permanent change of color from white to pink. No further addition of the alkali is necessary, as the first change of color indicates the point when the acid is all neutralized. A piece of white paper placed under the tumbler in which the cream is tested will help to show the change of color. It will be found to be more accurate to adopt as the end of the test the point when the first change of color appears and the cream is no longer white, rather than to try to get a certain shade of pink color every time.

The amount of alkali required to produce this change of color shows the sourness of the cream as indicated by this test. A change of color may be produced in 25 c. c. of sweet cream, by a solution of one or two tablets. As the sourness of the cream increases, 25 c. c. of it may require a solution of three, four, or five tablets to change the color.

The indications are that a cream which requires a solution of six or more tablets to change its color is too sour. The butter made from such cream will be "off flavor." The only general direction that can now be given as applicable to nearly all cream, is to churn it when 25 c. c. of the thoroughly mixed cream is not colored by a solution of four tablets but is decidedly colored by a solution of five tablets.

Some dairymen may prefer to churn a less acid cream and adopt the sourness of cream which will give a color with a solution of three tablets.

Comparative trials made by each person of the acidity of the cream and the flavor of the butter made from it will be a satisfactory guide to follow.

This test will show the sourness of each lot of cream so that a uniformity of acidity can be had in each churning. How much acidity each lot of cream should have, or whether cream should be churned sweet or sour, may be a matter of opinion with the butter maker. This test serves as an aid to show him when the cream is of the sweetness or sourness which he prefers. It will also show when the cream ought to be churned in order to prevent it from spoiling the butter by ripening too far and becoming too sour for the best results.

These tablets are made by Charles S. Baker & Co., Grand Crossing, Chicago, Illinois. The complete outfit, including one thousand tablets and one 25 c. c. pipette, costs $2.50 delivered. One thousand tablets ought to make 250 tests of cream.

E. H. FARRINGTON, M. S., Chemist.

All communications intended for the Station should be addressed, not to any person, but to the

AGRICULTURAL EXPERIMENT STATION, CHAMPAIGN, ILLINOIS.

The bulletins of the Experiment Station will be sent free of all charges to persons engaged in farming who may request that they be sent.

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UNIVERSITY OF ILLINOIS,

Agricultural Experiment Station.

CHAMPAIGN, JUNE 9, 1894.

BULLETIN NO. 33.

CONTENTS.—THE CHINCH BUG IN ILLINOIS, 1894.
ALKALINE TABLETS FOR TESTING THE ACIDITY OF CREAM.
CERTIFIED TESTS OF DAIRY COWS.

THE CHINCH BUG IN SOUTHERN ILLINOIS—1894.

In bulletin No. 19 of this Experiment Station, published in February, 1892, notice was given of the commencement of an extensive outbreak of the chinch bug in southern Illinois, with warning of its probable development in the following year. Acccording to our advices at that time, eight counties in the southern and south-central part of the state were injuriously infested, and eighteen other counties in the same region were mentioned in which the chinch bug was reported as of general occurrence in unusual numbers.

This attack increased in intensity during 1893, and this spring (1894) the chinch bugs emerged from their winter quarters in numbers sufficient to do great mischief in no less than twenty-four counties throughout the region above mentioned. The area seriously infested is practically the same as that to which attention was called in 1892, the counties now involved being Williamson, Jefferson, Perry, Washington, Clinton, Madison, Bond, Marion, Fayette, Clay, Richland, Jasper, Effingham, Cumberland, Montgomery, Macoupin, Scott, Morgan, Sangamon, Christian, Pike, Brown, Cass, and Henderson.

Economic measures now available are practically limited to experiments for the destruction of the chinch bugs in place by the introduction of their contagious diseases, and to the interposition of barriers between small grain and corn to prevent their passage from one to the other as infested fields of small grain ripen or are destroyed. To accumulate and kill them as they pass from field to field, a deep furrow may be plowed,—to be kept clean and as friable as possible, especially on the vertical side, next the field to be protected,—and in this the accumulating bugs may be killed by a mixture of kerosene and water (about one part to eight), thoroughly and repeatedly shaken together. A variation of this method, used very successfully in Wisconsin, is to lay a quantity of green wheat or oats or fresh corn stalks in the furrow, in which the chinch bugs can be killed with this kerosene mixture as they accumulate.

An added measure of success with the barrier method may be secured if two parallel furrows are made instead of one, and the soil between them be kept dusty. The chinch bugs escaping the kerosene mixture, or other destructive agent, in the outer furrow could then be killed in the second. If they succeed in passing these barriers and collect upon the outer rows of corn, they may there be killed with kerosene, which should then be applied in the form of an emulsion to prevent injury to the young corn itself. To prepare this fluid, mix two parts of kerosene with one part of strong hot soap-suds, and violently agitate the mixture with a hand force-pump until a permanent cream or butter is formed. This may then be diluted with ten or twelve parts of water, and applied either with a sprinkler, or in a spray from a hand force-pump.

A more expensive and less readily manageable method is the planting of strips of some favorite food plant, as spring wheat, or other quick growing succulent cereal or grass, around infested wheat or around corn to be protected, where the chinch bugs may accumulate and be destroyed before laying their eggs for the second generation of the year. The bugs may be confined to the strip, after having entered it, by furrows plowed all around it and attended to from day to day until the destruction is complete.

For the benefit of those who wish to experiment with the introduction of contagious diseases, arrangements have been made to infect and distribute live chinch bugs to farmers, the funds for this experiment having been furnished by the Board of Direction of the State Agricultural Experiment Station. Those wishing such material should send to the undersigned, with the least possible delay, a collection of some thousands of live insects, enclosed with a little green vegetation (wheat, oats, or corn) and no dirt, in a tin box large enough to hold from a pint to a quart. Upon receipt of these they will be exposed to infection by confining them in a tight box with a large quantity of dead and dying chinch bugs, and returned without charge to the senders, with full directions for use.

The results of this method are, however, not sufficiently certain to warrant an entire dependence upon it; and it should be made one feature only of a general and concerted campaign. I cannot too strongly insist upon the fact, emphasized by eleven years' experience with the chinch bug, that it is not to be mastered by any one measure or any one man, but that joint action on an intelligent programme of preventive and protective measures persistently followed up, offers the only valid hope of success.

S. A. Forbes, Ph. D., *State Entomologist.*

ALKALINE TABLETS FOR TESTING THE ACIDITY OF CREAM.

Since the first description of these tablets was published in bulletin No. 32, Professor Morrow, of this station, has made a valuable suggestion which has been adopted in the use of the tablets for testing the sourness of the cream. He suggested that substitution of one graduated bottle for the three or four separate bottles in which the tablets are dissolved in water. This is found to be an improvement, as it not only decreases the necessary manipulations, but enables the operator to measure a smaller amount of acidity in cream than is represented by one tablet. A 50 c. c. glass cylinder, graduated, and on a foot, is found to be a convenient piece of apparatus to use in preparing the solution of the tablets. It is made of stout glass, not easily broken, and can be obtained of any dealer in chemical apparatus. Put five tablets into this cylinder, add hot or cold soft water, until the cylinder is filled up to the 50 mark, then cork the cylinder and shake frequently until the tablets all disappear in solution. When the tablets are all dissolved, the reddish colored liquid can be poured into the 25 c. c. of cream which is to be tested, until the cream is no longer white, but retains a pinkish color. This is the end of the test. The amount of the tablet solution which was used to produce this color in the cream, is thus measured by noting the number of tablets which were dissolved in the 50 c. c. of water and the number of c. c. of this solution it was necessary to use to neutralize the acid of the cream.

Composition of the Tablets.

The tablets are made of sodium carbonate and phenolphthalein. The writer proposed the idea of mixing these two substances in the form of a tablet to a manufacturing chemist and requested him to make a trial of it. It was found by repeated trials and experiments of the manufacturer and the writer, that tablets could be made so that each one would contain a very exact amount of sodium carbonate, and there could be mixed with it a sufficient quantity of phenolphthalein to give a pink color to 25 c. c. of milk or cream, when the latter was made alkaline by the sodium carbonate.

The mixing of these substances and molding into tablets, requires the skill and machinery of a manufacturing chemist.

Their usefulness depends in a large measure on the exactness with which they are made. E. H. FARRINGTON, M. S., *Chemist.*

CERTIFIED TESTS OF DAIRY COWS.

The Illinois Agricultural Experiment Station will supervise tests of dairy herds and, in exceptional cases, of individual cows owned or exhibited in Illinois under the following conditions:

The number of tests so supervised, and the times at which they shall be made, will be determined by the practicability of sending an authorized representative for the purpose without serious interference with other work of the station, but it is expected that there can be prompt compliance with all requests.

Preference will be given to tests of pure bred herds or cows kept for the rearing of dairy stock, and to tests continuing seven days.

The Station, through its representative, shall receive full information as to breeding, age, time of calving, date when bred, and treatment of the cows prior to the tests; also have full opportunity to determine the quantity and kinds of food used, and the methods of feeding and treatment during the tests, with privilege of taking samples of the food for inspection or analysis, as well as the quantity and quality of the milk or butter product.

The results of the tests, duly certified by the Station, will be furnished as soon as determined to the owners of the cows, or to the associations under whose auspices the tests are made. The Station shall have the right to make publication of the results obtained, but no publication will be made without consent of owners or associations until after the completion of any public competition in which the cows have been entered.

The expenses of the representative of the Station in going to and returning from the tests as well as his maintenance during the tests shall be paid by the owners of the cows or the associations authorizing the tests.

Blanks giving the details of observations to be made in the tests will be sent on application to AGRICULTURAL EXPERIMENTAL STATION, Champaign, Ill. G. E. MORROW, A. M.,

President Board of Direction.

UNIVERSITY OF ILLINOIS,

Agricultural Experiment Station.

CHAMPAIGN, AUGUST, 1894.

BULLETIN NO. 34.

CONTENTS.

Experiments With Wheat, 1893–94.
Experiments With Oats, 1894.

EXPERIMENTS WITH WHEAT, 1893–94.

Results of experiments tried with wheat on the Station grounds in the season 1893–94 are here given, with reference to like experiments in previous years.

These experiments are reported:

No. 65. Quantity of Seed.
No. 116. Test of Varieties.

Temperature and Rainfall, July, 1893, to June, 1894.

	July 1893, to June 1894.		Average for 10 years.	
	Rain-fall.	Temper-ature.	Rain-fall.	Temper-ature.
July	.59	76.4	2.73	77.5
August	.06	71.1	3.45	74.6
September	3.62	66.5	3.27	66.5
October	1.14	53.3	3.27	54.6
November	2.98	37.3	2.76	40.6
December	1.09	30	2.47	27.1
January	1.95	29.4	1.54	22.8
February	1.33	24.7	3.42	29.7
March	2.41	43.5	2.61	39
April	1.80	51.4	3.19	52.4
May	3.30	59	4.45	64.6
June	1.78	73.4	5.04	71
Total	22.05	....	38.20	....

Experiment No. 116, Wheat, Test of Varieties.

The land used in this experiment was fairly level prairie soil, about one-half lying nearly six feet lower than the rest. The slope from the one to the other level gave to several of the plats a southeastern exposure. The others were nearly level. The land had not had exactly the same treatment in former years in the application of manure, but no differences in the crop could be traced to this cause. In 1891-92 this land had been in wheat. It was sown to wheat in the fall of 1892, but the crop was so badly injured by the winter that oats were sown in the spring of 1893. The land was plowed, harrowed, and rolled Sept. 24th to Sept. 26th. The wheat was drilled Sept 27th to 29th. The ground had been remarkably dry, but two inches of rain having fallen from July 1st to Sept. 23d, on which day there was a rainfall of 1.79 inches.

Seventy-five plats each 1 by 8 rods, or 1-20 of an acre, were sown. Seventy-two of these plats were in 8 rows of 9 plats each. The remaining three plats were placed across the end of the tract. Spaces of two feet were left between the sides and ends of the plats. The drill used was a five-hoe, one-horse drill, set to sow at the rate of six pecks per acre; but owing to differences in size and shape of the kernels of the different varieties the quantity actually sown varied from 6 to 8⅔ pecks per acre.

Sixty varieties, or samples under different names, were sown. There were four duplicate plats of one variety, six plats of mixtures, and six plats sown at different rates of seeding. The wheat made but very moderate growth during the autumn. A few plats with southeastern exposure were evidently injured during the winter or early spring. The wheat ripened from June 27th to July 3d, was harvested June 30th to July 3d, three or four plats being not quite so mature as the others at the latter date. The wheat on all the plats stood well. The average yields from the 75 plats was at the rate of 35.9 bu. per acre, the range being from 17.4 to 48.4 bu. Twenty-six plats gave yields of over 40 bu. each, and nine under 25 bu. per acre. The average yield of the sixty varieties was 35.6 bu. per acre. These are the yields of the plats as separately threshed. The "scattering" wheat from the 75 plats was sufficient to add nearly 2 bu. per acre to the average yield, but it was impossible to apportion this correctly to the different plats. The average weight of the wheat per bushel, as threshed and without special cleaning, was 61.6 pounds per bu., the range being from 58.5 to 63.5 pounds. The wheat from six plats weighed less than 60 lb. per bu.

Thirty-seven plats of bearded wheat averaged 35, and 30 plats of smooth averaged 36.8 bu. Thirteen plats of wheat classed as white averaged 34.7, and 56 classed as brown or red averaged 35.8 bu.

The average yield of straw was at the rate of 3,680 lb., varying from 1,435 to 5,375 lb. On each of 31 plats the yield of straw was at the rate of more than 4,000 and on 12 less than 3,000 lb. per acre. The average number of stubs on one square foot was 51, the range being from 34 to 65. The average height was 44 inches, the range being from 38 to 50 inches. In 1892 the number of stubs on a square foot varied from 34 to 77. The height in that year varied from 47 to 60 inches. In that year wheat harvest was unusually late, the cuttings being made from July 9th to 14th.

The average weight of 100 kernels of wheat in 1894 was 3.35 grams, the range being from 2.40 to 4.04. In 1892 the range of weight of 100 kernels was from 1.74 to 3.74 grams. In tests made at the Iowa Experiment Station, apparently with wheats of the crop of 1893, the number of kernels per bu. varied from, approximately, 490,000 to 1,184,000, with an average of 770,000. The average number of kernels per bushel of the wheat grown at this Station this year was a little over 800,000; the extremes being about 600,000 and 1,130,000.

With the exception of a few plats the yields were unusually good. It is to be noted that the year ending with June, 1894, was one of unusually light rainfall, the total being but 22.5 inches, and of this but 18.27 inches fell after the wheat was sown. In no one month was there a great rainfall, 3.30 inches in May being the greatest.

In no case should the merit of a variety otherwise apparently valuable be determined from its yield in any single year. In the trials here reported the variation in yields of different plats evidently depended much more on slight differences in exposure and elevation than on differences in variety. The greatest difference in the average yield of the plats in the 8 rows of 9 plats each was 4 bu. per acre, while the difference in yield of the cross rows of 8 plats was 14 bu. per acre. Four plats of one variety were sown in different parts of the tract of land. The yields of these were at the rates of 34.3, 35.2, 42.4, and 46.3 bu. per acre. The smallest yields were from plats with a southeastern exposure; the largest from level plats on slightly lower ground, with presumably somewhat greater natural fertility.

Through the kindness of Director Thorne, of the Ohio Station, at Wooster, of Professor Latta, of the Indiana Station, at LaFayette, and Director Armsby, of the Pennsylvania Station, at State College, we are enabled to give the yields of a number of varieties grown at each or all of these Stations. The comparatively low yields at the Ohio Station are explained as due to excessive drouth at time of sowing, which prevented the growth of much of the wheat, and also to treatment of the seed with a too strong solution of copper sulphate designed to destroy stinking smut with which the wheat was affected.

At this Station in 1894 the varieties giving the largest yields were New Michigan amber, 48.4; Yellow gypsy, 46.5; Crate, 45.5; Rock velvet, 45; Royal Australian, 44.7; Currell's prolific, 43.7; Diehl Mediterranean, 43.7; Missouri blue stem, 43.6; but it would not be safe to make this fact conclusive evidence of the superiority of these varieties over others tested. The wheat crop of 1893 was a failure. In 1892 the best yielding varieties were the following: Hindustan, Diehl Mediterranean, Dietz, Tuscan Island, Lehigh, Crate, Tasmania red. Currell's prolific also gave a large yield, as did Nigger, which gave a yield of 40 bushels in 1894. In trials for several successive years, Valley stood first at the Ohio Station, second in Pennsylvania, and third in Indiana.

At the Ohio and Indiana Stations Velvet chaff (Penquite's) has been grown as a standard variety. This is probably the same variety as that grown at this Station under the name Rock velvet.

The variety tests for two years, at this Station, as well as those made in the other states named, do not sustain the claims made for wonderful productiveness of varieties recently introduced. Some of these seem to be identical with well known varieties.

In 1892 the yields of each of four plats sown with a mixture of several varieties was somewhat greater than the average of the varieties composing this mixture. Seed from these mixtures was sown in fall of 1893. In but one case was the yield greater than the average yield of all the plats, and in but one was it greater than that of the plats adjoining.

The Station has no seed wheat for sale.

SECOND CROP GROWN FROM MIXTURES, 1893-4.

	Wt. 100 kernels, grams.	Lb. per bu.	Yield per Acre.	
			Straw, lb.	Grain, bu.
Components of Mixture A.				
*Velvet chaff	....	....	....	....
Lehigh	3.56	60	3555	30.7
Hindustan	3.64	63	3955	39.4
Tasmania red	3.54	62	3990	40.2
Nigger	3.19	60.5	4985	40.3
Diehl Mediterranean	3.66	62.5	4680	43.7
Tuscan Island	4.01	62.5	3775	38.7
Miami Valley	3.38	63.5	3240	30.7
*Longberry Wabash	....	....	....	....
Bearded Monarch	3.36	61.5	3715	39.4
*Fairfield	....	....	....	....
Average of above	3.54	61.8	3987	37.9
Yield from mixture *a* (av. 2 plats)	3.31	62	3020	26.6
Components of Mixture B.				
Wyandot red	3.44	62	3440	37.3
Poole	3.39	62.5	3325	41.2
Witter	3.11	62.5	4180	41
*Sheriff	....	....	....	....
*Hicks	....	....	....	....
*Fultz	....	....	....	....
Currell's prolific	3.23	62	3915	43.7
Oregon	2.97	62.5	4315	41.4
Longberry	3.33	61.5	3565	37.9
Early ripe	3.29	61	4330	33.1
Average of above	3.25	62	3867	39.4
Yield from mixture *b*	3.20	60.5	4240	39.3
Components of Mixture C.				
*Russian red	....	....	....	....
Improved rice	3.48	62	3425	32.9
Extra early Oakley	3.39	62.5	3765	37.2
Crate	3.87	62	4550	45.5
Average of above	3.58	62	3913	38.5
Yield from mixture *c*	3.29	61	3065	29.6
Components of Mixture D.				
*Deitz	....	....	....	....
Lebanon	4.04	62	4020	40
Theiss	3.10	62.5	3095	34.7
Average of above	3.57	62	3557	37.3
Yield from mixture *d* (av. 2 plats)	3.40	62.5	3447	37

*Not grown in 1894.

WHEAT, VARIETY TEST, 1893-94.

Plat No.	Name of variety.	Source of seed.	Per cent germinated in apparatus.	When Drilled.	Lb. and oz. sown per plat.	Ripe	Harvested.	Height.	Bearded or smooth.	Color of kernel.	Color of straw.	Color of chaff	No. of stubs on 1 sq. foot	Weight of 100 kernels, g.	Condition when cut.	Lb. per bu.	Yield per acre.	
				Sept		June	June	inch.									Lb. straw.	Bu. grain.
1	Big English	Ill. Exp't Station, '92.	77	27	4–9	29	30	43	S	R	l b	† w	57	3.12	leaning	62	3705	34.9
2	Golden cross	"	87	"	4–15	29	30	44	B	R	r b	b	47	3.90	erect	61.5	4125	40.6
3	Longberry	"	91	"	5–1	27	30	42	S	R	l b	w	47	3.33	"	61.5	3565	37.9
4	Mealy	"	80	"	4–9	28	30	41	S	R	r b	w	54	3.17	"	61.5	3835	41.4
5	Wyandot red	"	78	"	5–3	28	30	42	S	R	r b	w	52	3.44	"	62	3440	37.3
6	Miami Valley	"	90	"	5–2	30	30	43	B	R	r b	w	53	3.38	"	63.5	3240	30.7
7	Valley	Ohio Exp't Station, '93.	90	28	....	29	30	46	B	R	l b	w	45	3.37	leaning	62.5	3430	29.5
8	German emperor	Ill. Exp't Station, '92.	88	"	5–1	30	30	42	S	R	r b	b	55	3.28	erect	61	4280	34
9	Early ripe	"	91	"	4–14	30	30	46	S	R	r b	b	58	3.29	"	61	4330	33.1
10	Tuscan Island	"	76	27	5–9	30	30	44	B	R	r b	w	61	4.01	leaning	62.5	3775	38.7
11	Ohio early ripe	"	87	"	5–3	29	30	40	S	R	r b	b	55	3.39	erect	62	3525	34.2
12	Hybrid Mediterranean	"	88	"	4–15	29	30	43	B	R	r b	b	48	3.78	"	62	3530	37.8
13	Extra early Oakley	"	81	"	5–3	29	30	45	S	R	r b	w	61	3.39	"	62.5	3765	37.2
14	Poole	"	75	"	5–14	29	30	42	S	R	r b	b	46	3.39	"	62.5	3325	41.2
15	Improved rice	"	80	"	5–5	28	30	44	S	R	r b	w	52	3.48	"	62	3425	32.9
16	Rudy	"	..	28	5	30	30	44	B	R	r b	b	48	3.21	leaning	60.5	2860	25
17	Mixture *a*	"	83	"	4–12	30	30	46	B	R	r b	b	57	3.46	erect	62	4095	29.7
18	Martin's amber	"	61	"	4–13	July 3	July 3	48	S	W	l b	w	60	2.99	"	62	4320	37.3
19	Mixture *d*	"	88	27	4–15	30	" 2	46	B	R	l b	w	63	3.41	leaning	63	3850	41.8
20	New monarch	"	81	"	5–3	28	" 2	42	S	W	l b	b	44	3.20	erect	60	2880	27
21	German emperor	"	82	"	5–4	28	" 2	43	S	R	r b	b	43	3.49	"	61 5	2640	31
22	Saskatchewan	"	80	28	4–6	July 2	" 2	41	S	R	r b	b	56	2.85	"	60.5	3535	32.7
23	Dietz longberry	"	90	"	4–12	29	" 2	44	B	R	l b	w	47	4.04	"	61	3765	37.6
24	Oregon	"	75	"	4–15	29	" 2	46	S	R	l b	w	65	2.97	"	62.5	4315	41.4
25	Lehigh	Ohio Exp't Station, '93.	83	"	6–5	July 3	" 2	47	B	R	r b	b	53	3.56	"	60	3555	30.7
26	Ontario wonder	"	81	"	5–13	" 3	" 3	46	S	R	l b	w	55	3.08	"	62.5	4510	39.8
27	Valley	"	90	"	....	" 3	" 3	49	B	R	l b	w	62	3.20	"	63	4855	42.4
28	Early white leader	"	73	"	5–6	" 2	" 2	48	S	W	l b	w	43	3.20	leaning	59	4380	37
29	Roberts	"	69	"	6–2	29	" 2	40	B	R	r b	b	34	3.68	erect	61.5	2370	24.8
30	Valley	"	90	"	....	27	" 2	44	B	R	l b	w	41	3.37	"	63	3065	35.2
31	Yellow gypsy	"	80	"	6–6	28	" 2	44	B	W	l b	b	55	3.32	"	62	4530	46.5
32	Pickaway	"	74	"	6–7	30	" 2	44	B	R	r b	b	49	3.90	"	61.5	4565	41.9
33	Witter	"	96	"	6–4	July 1	" 2	45	S	R	l b	b	52	3.11	"	62.5	4180	41
34	Hickman	"	86	"	6–2	29	" 2	47	S	R	l b	w	67	3.47	leaning	61.5	4665	38.6
35	Nigger	"	93	"	5–1	30	" 2	44	B	R	r b	b	61	3.19	erect	60.5	4985	40.3
36	New Michigan amber	"	88	"	6–8	29	" 2	47	B	R	l b	w	65	3.77	"	61.5	4855	48.4
37	Geneva	"	84	"	6–7	28	" 2	42	B	R	l b	w	54	3.39	"	63.5	3710	35.5
38	Theiss	"	90	"	6–2	29	" 2	41	B	R	r b	w	53	3.10	"	62.5	3095	34.7
39	Bailey	"	86	"	5–7	29	" 2	42	B	W	l b	b	37	2.64	"	58.5	2245	24.6

40	Jones' square head	“	85	“	5–9	July 1	“ 2	40	S	W	l b	w	45	3.10	“	59	4035	38.7
41	Hindustan	“	88	“	6–8	30	“ 2	45	B	R	r b	b	50	3.64	“	63	3955	39.4
42	American bronze	“	97	“	5–12	July 1	“ 2	46	S	R	l b	w	39	3.47	“	61	4475	41.7
43	Landreth	“	80	“	5–11	“ 2	“ 2	48	S	R	l b	w	55	3.13	leaning	59	5375	34.8
44	Rock velvet	“	76	28	6–8	28	July 2	44	B	W	l b	b	52	3.36	erect	63	4740	45
45	Crate	“	86	“	6–8	July 2	“ 2	48	B	R	r b	b	57	3.87	leaning	62	4550	45.5
46	Buckeye	“	90	“	5–11	30	30	41	B	R	r b	b	37	3.17	erect	61	2780	28.3
47	Johnson	“	81	29	5–9	July 2	30	41	B	W	l b	w	35	2.84	“	60	2025	22.9
48	Beal	“	62	“	5–8	30	30	38	B	W	l b	w	34	2.40	“	59	1435	17.4
49	Bearded monarch	“	87	“	6	29	30	42	B	R	l b	b	51	3.36	“	61.5	3715	39.4
50	Missouri blue stem	“	67	“	6–4	July 1	30	46	B	R	r b	b	49	3.84	“	62	4105	43.6
51	Millers' prolific	“	85	“	5–11	30	30	39	S	RW	l b	b	54	3.41	“	62	3590	38.2
52	Silver chaff	“	65	28	6–1	July 2	30	50	S	W	l b	w	55	3.38	leaning	62	5140	41.3
53	Diehl Mediterranean	“	92	“	6–11	“ 1	30	47	B	R	r b	b	54	3.66	erect	62.5	4680	43.7
54	Tasmanian red	“	86	“	6–8	“ 3	30	48	B	R	r b	b	61	3.54	leaning	62	3990	40.2
55	Democrat	“	87	“	6–3	29	30	44	B	W	l b	w	45	2.96	erect	62	2575	25.1
56	Early red clawson	“	75	29	5–5	30	30	39	S	R	l b	b	36	3.63	“	61	1780	27
57	Fulcaster	“	60	“	6–3	29	30	39	B	R	r b	b	34	3.58	“	62.5	1735	20.1
58	Golden prolific	“	90	“	5–9	29	30	42	S	W	l b	b	43	3.87	“	60.5	4155	43.1
59	Valley	“	90	“	....	30	30	44	B	R	l b	w	53	3.42	“	62 5	4440	46.3
60	Yuba	“	88	“	6–6	30	30	44	B	R	r b	b	47	3.96	“	61	3345	39.2
61	Currell's prolific	“	76	“	....	30	30	42	S	R	r b	b	56	3.23	“	62	3915	43.7
64	Willits	“	71	“	4–14	July 1	29	40	S	R	l b	w	39	2.91	“	60	2510	23.2
65	Mixture *a*	Ill. Exp't Station, '92.	..	“	5–12	30	29	42	B	R	r b	w&b	38	3.17	“	62.5	1945	23.6
66	Sibley's new golden	Ohio Exp't Station, '93.	85	“	6–3	29	29	43	B	R	r b	b	45	3.22	“	60	2170	19.2
67	Lebanon	“	85	“	6–8	29	29	45	B	R	l b	w	50	4.04	“	62	4020	40
68	Royal Australian	“	75	“	5–14	July 1	July 1	45	S	W	l b	b	54	3.13	leaning	59.5	4815	44.7
69	Mixture *b*	Ill. Exp't Station, '92.	..	“	4–8	30	30	45	S	R	l b	b	56	3 20	erect	60.5	4240	39.3
73	Mixture *d*	“	88	“	4–12	30	30	41	....	R	......	......	55	3.38	....	62.5	3045	32.2
74	Badger	Ohio Exp't Station, '93.	86	“	5–13	30	30	43	....	R	......	......	58	3.48	....	62.5	3135	29.8
75	Mixture *c*	Ill. Exp't Station, '92.	..	“	4–12	30	30	46	....	R	......	......	55	3.29	....	61	3065	29.6

* l b light brown, r b reddish brown. † w white, b brown.

Yields of Varieties of Wheat named at the Experiment Stations of Illinois, Indiana, Ohio, and Pennsylvania—Season of 1893-94.

Variety.	Yields.			
	Illinois.	Indiana.	Ohio.	Pennsylvania
American bronze	41.7	....	19.2	26.4
Badger	29.8	....	16.8	....
Bailey	24.6	....	....	....
Beal	17.4	36.7	....	....
Bearded monarch	39.4	....	22.2	....
Big English	34.9	....	....	....
Buckeye	28.3	....	....	....
Canada wonder	....	41.3	....	34
Canadian hybrid	....	38.3	21	....
Crate	45.5	....	12.5	....
Currell's prolific	43.7	....	16.2	28.5
Dale	....	....	....	28
Deitz	....	....	16.9	31.8
Democrat	25.1	....	15	28.8
Diehl Mediterranean	43.7	....	18.5	28.1
Dietz longberry	37.6	30.9	....	30.7
Earliest of all	....	....	....	25.1
Early Genesee giant	....	40.3	19.6	....
Early red Clawson	27	....	14	....
Early ripe	33.1	32.2	19.7	....
Early white leader	37	....	18.8	....
Egyptian	....	....	14.7	30.6
Extra early Oakley	37.2	....	21.4	32.1
Fairfield	....	....	18.2	....
Finley	....	....	....	30.9
Fulcaster	20.1	40.3	14.5	33.5
Fultz	....	39.7	24.1	31.3
Fultz blue stem	....	....	12.6	....
Geneva	35.5	....	28.2	....
German emperor	32.5	....	....	32.3
Gold dust	....	30.5	....	....
Golden cross	40.6	....	....	....
Golden prolific	43.1	....	19.4	....
Gypsy	....	....	18.5	....
Harvest queen	....	40.7	....	....
Hickman	38.6	37.2	19.8	....
Hindustan	39.4	....	8.8	....
Hybrid Mediteranean	37.8	....	....	....
Improved rice	32.9	....	....	25.8
Johnson	22.9	35.3	....	....
Jones' American bronze	....	41.7	....	....
Jones' square head	38.7	....	11.8	29.5
Jones' winter fife	....	43.5	15.8	29.9
Kentucky giant	....	37.3	27.2	....
Landreth	34.8	....	....	....
Lebanon	40	....	14.2	28.8
Lehigh	30.7	....	10	....
Longberry	37.9	29.1	....	....
Longberry red Wabash	....	34.1	10	....
Martin's amber	37.3	....	13.8	....
McGhees' red	....	....	....	28.7
Mealy	41.4	....	33.1	28.1
Mediterranean	....	....	15.2	30.1
Miami red	....	....	12.4	....
Miami Valley	30.7	....	....	28.7
Miller's prolific	38.2	....	20.7	22.2
Missouri blue stem	43.6	....	14.6	....
New Columbia	....	....	32.2	....
New Michigan amber	48.4	35.7	17.2	....

Yields of Varieties of Wheat named at the Ex[illegible]ment Stations of Illinois, Indiana, Ohio, and Pennsylvania—Season [illegible] 1893-94—*Continued.*

Variety.	Yields.			
	Illinois.	Indi[illegible]	Ohio.	Pennsylvania
New monarch	27	37.2	[illegible]	[illegible]
Nigger	40.3	37	[illegible]	[illegible]
Ohio blue stem	....	33.2	22.2	....
Ohio early ripe	34.2	....	[illegible].2	31
Ontario wonder	39.8	....	....	....
Oregon	41.4	....	....	....
Pickaway	41.9	....	....	36.6
Poole	41.2	....	29[illegible]	29.4
Post	....	....	20[illegible]	....
Pride of Illinois	....	33.7	....	31.9
Raub's black prolific	....	35.7	....	....
Red Clawson	....	36.5	....	....
Red Fultz	....	....	21.7	28.4
Red Russian	....	....	25.6	[illegible]
Red wonder	....	37.5	....	....
Reliable	....	....	....	38
Reliable Minn	....	42.9	....	....
Roberts	24.8	28.1	....	....
Rochester red	....	34.9	14.5	....
Rock velvet	45	....	15	....
Roumania	....	....	....	29.1
Royal Australian	44.7	....	9.9	31.9
Rudy	25	45.7	13.7	35.3
Saskatchewan	32.7	....	....	....
Sheriff	....	....	....	25.3
Sibley's new golden	19.2	....	11.5	29.4
Silver chaff	41.3	....	14.2	....
Surprise	....	....	22.2	....
Tasmania red	40.2	....	13.2	29.1
Theiss	34.7	....	15.2	31.9
Tuscan Island	38.7	....	22.5	30.4
Valley	38.3	39.1	13.7	32.4
Velvet chaff	....	37	17.4	28.2
Weedlen	....	36	....	....
Wicks	....	....	....	28.3
Willits	23.2	36.7	....	....
Wisconsin triumph	....	....	23.6	....
Witter	41	....	....	29.3
World's Fair	....	34.7	30.7	....
Wyandot red	37.3	41.1	20.2	29.8
Yellow gypsy	46.5	....	18.2	....
Yuba	39.2	....	....	....

AVERAGE YIELD OF VARIETIES OF W[redacted]EAT FOR A SERIES OF YEARS AT THE EXPERIMENT STATIONS IN ILLIN[redacted], INDIANA, OHIO, AND PENNSYLVANIA.

Rank.	Name of variety.	Illinois.		Indiana.		Ohio.		Penn.		Av. of all	
		Years grown.	Bu. per acre	Years grown.	Bu. per acre.	Years grown.	Bu. per acre.	Years grown.	Bu. per acre.	No. of trials.	Bu. per acre.
	Seven or more [redacted]										
1	Poole......[redacted].										
2	Valley ......[redacted]........	2	36.7	....	....	10	33.9	1	31.9	13	34.2
3	Royal Australia[redacted]r[redacted].........	1	38.3	5	31.1	10	35.2	5	31.3	21	33.4
4	Tasmania re[redacted]d[redacted].........	1	44.7	....	....	10	31.2	1	31.9	12	32.4
5	Nigger.....[redacted]nb[redacted].........	2	36.8	....	....	10	31.7	1	29.1	13	32.3
6	Diehl Medi[redacted]red[redacted].........	2	36	2	29.1	10	34.1	5	27.1	19	31.9
7	Ontario w[redacted]slan[redacted]ean.........	1	43.7	....	....	10	32.9	5	27.4	16	31.9
8	Martin's [redacted]n bl[redacted].........	2	32.4	....	....	..	....	5	30.9	7	31.3
9	Wyand[redacted]rat..[redacted].........	2	32.3	....	....	10	30.6	....	....	12	30.9
10	Tuscan[redacted]Mich[redacted].........	2	33.7	....	....	7	30.1	5	30.5	14	30.8
11	Misso[redacted]ell's [redacted].........	2	36.4	....	....	7	31.6	5	26.2	14	30.4
12	Dem[redacted]ss..[redacted]e stem.........	1	43.6	....	....	7	29	....	....	8	30.4
13	Ne[redacted]aly.[redacted]or.........	2	27.7	....	....	10	31.9	5	28.2	17	30.3
14	C[redacted]etz l[redacted]gan amber.........	1	48.4	11	29.9	1	17.2	....	....	13	30.3
15	T[redacted]udy[redacted]t prolific.........	2	37	....	....	1	16.2	5	30.5	8	30.3
16 1[redacted]	[redacted]Gern[redacted] Sibl[redacted]is.........	2	30.5	....	....	10	29.5	5	29.1	17	29.5
21	Fu[redacted]ur.........	2	33.5	....	....	1	33.1	5	27.1	8	29.4
22	N[redacted]ocongberry red.........	2	33.8	9	27.1	....	....	5	30.8	16	29.1
23	[redacted]w M.........	2	26.8	3	33.4	1	13.7	1	35.3	7	29
24	[redacted]rrean emperor.........	2	31	....	....	....	....	5	28	7	28.9
2[redacted]	[redacted]heey's new golden.........	1	19.2	....	...	7	28.8	5	27.9	13	27.7
[redacted]	Me[redacted]caster.........	2	23.9	8	28	1	14.5	5	31.1	16	27.6
[redacted]7	Di[redacted]w monarch.........	2	24.5	8	28.9	1	22.2	....	....	11	27.5
18	Rxtra early Oakley.........	2	33.2	....	....	7	25.3	5	28.1	14	27.4
19	(mproved rice.........	2	31.6	....	....	....	....	5	23.7	7	26
2	Miller's prolific.........	2	27.2	....	....	7	25.7	5	22.2	14	24.7
	Three to five trials.										
1	Oregon.........	2	35.1	....	....	....	....	1	29.4	3	33.2
2	Witter.........	2	34.1	....	....	....	....	1	29.3	3	32.5
3	Yellow gypsy.........	1	46.5	....	....	....	....	1	18.2	2	32.3
4	Hickman.........	1	38.6	1	37.2	1	19.8	....	....	3	31.9
5	Geneva.........	1	35.5	....	....	1	28.2	....	....	2	31.8
6	Longberry.........	2	34	3	29.1	....	....	....	....	5	31.1
7	Crate.........	2	39.6	....	----	1	12.5	....	....	3	30.6
8	Bearded monarch.........	2	34.3	....	....	1	22.2	....	...	3	30.3
9	Rock velvet.........	1	45	....	....	1	15	....	....	3	30
10	Miami Valley.........	2	29.7	....	....	....	....	1	28.7	3	29.4
11	Lebanon.........	2	35.3	....	....	1	14.2	1	28.8	4	28.4
12	Hindustan.........	2	37.4	....	....	1	8.8	....	....	3	27.9
13	Early white leader.........	1	37	....	....	1	18.8	....	....	2	27.9
14	Willits.........	1	23.2	3	28.9	....	....	....	....	4	27.5
15	Johnson.........	1	22.9	3	27.3	....	....	....	....	4	26.2
16	Early ripe.........	2	30.5	2	24.1	1	19.7	....	....	5	25.8
17	Lehigh.........	2	32.4	....	....	1	10	....	....	3	24.9
18	Beal.........	1	17.4	3	27.2	....	....	....	....	4	24.7

Experiment No. 65, Wheat, Quantity of Seed.

Six plats were sown with different quantities of seed. The drill being set to sow from 3 to 9 pecks per acre, but it is probable that in each case a somewhat greater quantity was sown. The largest yield was from plats sown at the rate of four pecks per acre, second from sowing six, and third from sowing eight pecks per acre. The plat sown at the rate of seven pecks per acre was injured by rabbits. In trials for five years slightly the largest yields have come from sowing eight pecks per acre, but there was a difference of only one bushel per acre whether four, six, or eight pecks were sown. Under favorable conditions the thinner sown wheat has a larger number of stalks per stool.

YIELDS FROM DIFFERENT AMOUNTS OF SEED, 1893-94.

Plat.	Amount sown	Wt. 100 kernels, grams	Stubs on 1 sq. ft.	Lb. per bu.	Yield per acre.	
					Lb. straw	Grain, bu.
62	3 pk. per acre	3.12	55	62.5	3515	39.2
63	4 " "	2.93	57	63	4000	44.7
61	6 " "	3.23	56	62	3915	43.7
72	7 " "	2.96	56	63	3545	34.2
71	8 " "	3.05	60	62.5	4025	42.2
70	9 " "	3.21	54	62	4290	40.5

YIELD OF WHEAT FROM DIFFERENT AMOUNTS OF SEED, 1888-89 to 1893-94.

Seed per acre—pecks	Yield per acre.											
	1888-9		1889-90		1890-91		1891-92		1893-94		Average	
	Straw lb.	Grain bu	Straw lb.	Grain bu.	Straw lb.	Grain bu.	Straw lb.	Grain bu.	Straw lb.	Grain bu.	Straw lb.	Grain bu.
3	....	....	2215	24.6	4140	22	....	....	3515	39.2	3290	28.6
4	4560	36.2	2620	28.2	4400	23.7	2575	24.7	4000	44.7	3631	31.5
5	4700	38.3	2740	26.3	4080	22.2	3357	29	....	....	3719	28.9
6	4750	36.3	2200	24.5	4980	28.3	3045	25.9	3915	43.7	3778	31.7
7	....	....	....	....	....	....	....	....	3545	34.2	....	....
8	4540	35.4	2740	28.3	5100	26.8	2670	27.8	4025	42.2	3815	32.1
9	...	....	....	....	...	....	....	....	4290	40.5	....	...

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EXPERIMENTS WITH OATS, 1894.

Results of experiments with oats on the Station grounds in the season of 1894 are here reported. Of these *No. 84, Oats, Test of Varieties*, is the only one reported in detail.

The land on which the experiments were tried was fertile prairie soil, which had been in corn in 1892 and 1893. The stalks of the last crop were removed and the land was plowed about 5 in. deep in the late fall of 1893. The plats, 48 in number, were 2 by 4 rods or 1-20 of an acre, with a space of 2 feet between. The first part of March was unusually favorable for farm work. The land was disked once with a cut-away disk or harrow, and plats 1 to 24 were seeded broadcast at the rate of 2½ bu. per acre March 16th and 17th. March 24th plats 25 to 32 were sown. All the plats were disked once after sowing, then harrowed, clover and timothy seed was sown, and then the plats were harrowed again. In all cases the seeding was at the rate of 2½ bu. of 32 lb. per acre, except with plats 28 and 32. On plat 28, 3¾ lbs., and on plat 32, 2 lb. were sown. March 25th, 26th, and 27th the temperature fell to a minimum of 12, 10, and 11 degrees. The severe freezing injured all the oats to some extent, but to a much greater extent on some plats than on others. April 14th plats 1 to 24, inclusive, which had been sown March 16th and 17th, were re-sown with the same varieties and like amount as before. The oats on plats 25 to 32 did not seem to be much injured, and were allowed to remain.

The oats ripened and were harvested from July 13th to 20th. Those on four plats were considerably lodged; on one all were lodged.

Fifteen varieties were sown on duplicate plats. Twelve of these varieties had been selected from a considerably larger number tested in previous years. The duplicate plats in all cases were at considerable distance from each other, with the design of equalizing any differences in the soil. Except for slight variations in elevation and exposure the soil of all the plats was apparently more than usually uniform, but the yields from plats of the same variety differed in a marked degree in a number of cases. Two varieties were tested on single plats. Duplicate plats were sown with each of three mixtures of varieties possessing like characteristics; also duplicate plats with oats grown on plats sown with the same mixtures in 1892. Two plats were rolled after being sown. Two plats were drilled, the quantity of seed being less than that used in sowing broadcast, owing to failure of the drill to sow the desired quantity.

The average yield of the 48 plats was at the rate of 62.3 bu., the range being from 40.8 bu. to 75 bu. per acre. Five plats gave yields of less than 50, and 7 of over 70 bu. each per acre. The average yield of the 32 plats in the variety test was 63 bu. per acre. The average weight per bushel from all the plats was 32.6 lb., range being from 28.5 to 37.7. These weights were taken as threshed and without special cleaning. The average weight of 100 berries was 2.27 grams, the range being from 1.71 to 2.70 grams. This gives the average number of kernels per bushel appproximately as 640,000, the range being from 537,000 to 850,000.

The average weight of straw was 3,300 lb. per acre, the range being from 2,560 to 4,545. The average number of stubs on one square foot was 44, the range being from 33 to 61. The average height of the straw was 37 in., the range being from 31 to 42.

As in former years the different varieties were found to vary materially in the per cent of the husk surrounding the kernel of the berries. The average per cent of the kernel was 72.1, the range being from 66.8 to 76.6. This variation of about 10 per cent is less than has been found in former years.

The best yielding varieties were: Texas rust proof, 74 bu. per acre; Lincoln, 68.7 bu.; Texas red, 68.2 bu.; New Dakota gray, 67.3 bu.; Calgary gray, 67.6 bu.; New red rust proof, 67.1 bu.; American banner, 64.4 bu.; Green Mountain, 64.4 bu.; Pringle's progress, 64.3 bu.

In trials for five years the best yielding varieties have stood in following order: Pringle's progress, Texas rust proof, New Dakota gray, New red rust proof, American banner, Improved American. Calgary gray has been grown two seasons. It ranked third among 59 varieties in 1892.

A small package of oats, unnamed, sent by Thomas Weaver, Nashville, Tenn., apparently gave a good yield, and ripened ten days or more in advance of any other variety.

Each of the mixtures of varieties gave a slightly larger yield than the average yield of the varieties used in making the mixtures, while the yield of the plats sown with seed, the product of mixtures in 1892, was slightly lower than the average yield of the varieties making the mixture.

Rolling the plats after the seed was sown did not seem to affect the yield. The two plats drilled instead of sown broadcast gave yields much below the average, but this may have been because a less quantity of seed was used.

This is the first year since the Station was established in which early sown oats have been injured by frost. Several half acre plats, not reported upon, which were sown previous to the severe frost, gave yields of from 50 to 60 bu. per acre.

SYNOPSIS OF VARIETIES.

Oats.	Early....	Panicles open..	White	Long..	Pringle's progress....64.3		63.6
					Early Dakota........56.9		
					Green mountain.....64.4		
					Lincoln.............68.7		
				Short.	Superior Scotch.....47.1		
			Black.	Long..	Black Russian.......62		64.8
					Calgary gray.......67.6		
			Dun..	Long..	Texas rust proof.....74		69.8
					New red rust proof..67.1		
					Texas red...........68.2		
	Medium .	Panicles open..	White	Long..	Improved American..62.1		63.2
					American banner....64.4		
				Short.	Australian..........54.4		
	Late	Panicles open..	White	Short.	Japan..............60.3		
		Panicles close..	Black.	Long..	New Dakota gray....67.3		
					Black prolific.......64.3		61.3
					Mammoth cluster....58.3		

COMPARATIVE YIELD OF VARIETIES OF OATS, 1894.

Plat No.	Name of Variety.	Bu.	Comparative Yield.
2 & 14	Texas rust proof...	74	
28	Lincoln	68.7	
3 & 15	Texas red.........	68.2	
7 & 19	Calgary gray......	67.6	
4 & 16	New Dakota gray..	67.3	
1 & 13	New red rust proof.	67.1	
12 & 24	American banner...	64.4	
27 & 31	Green mountain..	64.4	
8 & 20	Pringle's progress..	64.3	
6 & 18	Black prolific	64.3	
11 & 23	Improved American	62.1	
5 & 17	Black Russian.....	62	
9 & 21	Japan.............	60.3	
32	Mammoth cluster..	58.3	
10 & 22	Early Dakota......	56.9	
26 & 30	Australian	54.4	
25 & 29	Superior Scotch...	47.1	

The yields of oats in 1894 were the largest that have been grown at the Station since the year 1891, when the average yields from 55 plats was 66.6 bu., with a maximum of 85 bu. per acre. It is of interest to note that in each of these years both the winter and the growing season for the oats crop had a rainfall below the average, and were without excessive rain in any one month.

The experiments in previous years as to the quantity of seed to be sown, the time and manner of sowing, and time of harvesting, gave results of such uniformity that it was not thought necessary to re-

RESULTS OF VARIETY TEST OF OATS, 1894.

Plat No.	Variety.	Source of seed.	Per cent germinated.	Yield per acre.			Lb. straw per bu. grain.	Lb. per bu.	Height inches	When ripe. July	When cut.	Stubs per square foot.	Per cent. standing when cut.	Wt. 100 berries, grams		Per c't. kernel in b'ri's.	
				Grain bu.	Av. of 2 plats	Straw lb.								In seed.	In crop.	In seed.	In crop.
1	New red rust proof.	Station, crop of '92........	98	66.1	67.1	2945	1.39	28.5	37	13	13	42	75	2.08	2.44	74.1	71.5
13	"	" " '91........	96	68.1		2740	1.25	30.75	31	13	13	44	100	2.70	2.17	74.3	69.9
2	Texas rust proof...	" " '92........	96	73.1	74	3240	1.34	32	35	13	13	49	100	2.53	2.41	72.7	75.9
14	"	" " '91........	92	75		2720	1.13	34	34	14	16	42	100	2.60	2.63	75.5	74.6
3	Texas red.........	" " '92........	90	68.7	68.2	3320	1.51	33	36	13	13	46	100	2.51	2.41	72.7	74
15	"	" " '92........	90	67.8		2750	1.27	32.75	35	13	13	41	100	2.51	2.17	72.7	73.3
4	New Dakota gray..	" " '92........	96	73.1	67.3	4540	1.94	28.5	36	20	19	46	100	2.15	2.00	65.3	65.6
16	"	" " '91........	93	61.6		3710	1.88	33	37	20	19	37	100	2.43	2.38	69.4	69.5
5	Black Russian.....	" " '92........	90	62.5	62	2560	1.28	33	33	14	16	50	40	2.07	2.27	74.4	76.6
17	"	" " '91........	95	61.4		3635	1.85	31.25	35	19	19	43	100	2.22	2.30	71.4	73
6	Black prolific......	" " '92........	93	66.7	64.3	4545	2.23	32	34	20	19	55	100	1.93	1.90	67.0	71.4
18	"	" " '91........	83	62		3935	1.98	29	39	20	19	40	100	2.24	2.27	69.5	70.5
7	Calgary gray	" " '92........	92	73.6	67.6	3065	1.30	32.5	34	13	13	61	100	2.08	1.90	77.4	76.6
19	"	" " '92........	92	61.6		2950	1.50	31.75	36	13	16	49	90	2.08	1.90	77.4	76.6
8	Pringle's progress..	" " '92........	90	62.7	64.3	3175	1.58	31.75	38	14	13	41	90	2.34	1.84	67.9	68.2
20	"	" " '91........	....	65.9		2850	1.35	30	36	13	13	41	80	2.34	2.30	67.9	66.8
9	Japan............	" " '91........	90	64.5	60.3	4540	2.19	34.25	40	19	19	48	95	2.49	2.11	71.9	68.9
21	"	" " '91........	90	56.1		4125	2.29	35.25	39	19	19	37	100	2.49	2.35	71.9	72.7
10	Early Dakota......	" " '91........	99	63	56.9	3425	1.70	31.75	36	15	16	51	95	2.37	1.96	74.5	75.3
22	"	" " '91........	99	50.8		3575	2.20	32.5	39	14	16	55	95	2.37	1.71	74.5	71.4
11	Imp. American....	" " '92........	100	62	62.1	3215	1.67	33.75	38	16	16	46	100	2.32	2.67	69.6	74.8
23	"	" " '91........	95	62.3		3365	1.69	32.75	40	15	16	36	90	2.54	2.70	72.3	73.8
12	American banner..	" " '91........	92	70.2	64.4	2995	1.33	32	39	16	16	53	100	2.57	2.63	72.7	70.9
24	"	" " '91........	92	58.6		3885	1.97	32.25	42	15	16	43	75	2.57	2.41	72.7	70.8
25	Superior Scotch ...	J A Everitt, Indianapolis, Ind. ...	94	52.2	47.1	2810	1.68	35	37	13	13	41	25	.....	2.53	.....	71
29	"	" "	94	42		3095	2.30	37.75	39	13	13	45	0	.....	2.22	.....	68.1
26	Australian.........	Frank Ford & Son, Ravena, O.....	91	59.1	54.4	3390	1.79	34.25	...	15	16	35	85	.....	2.13	.....	71.8
30	"	" "	91	49.8		3765	2.36	35.75	38	17	16	37	25	.....	2.17	.....	70.8
27	Green Mountain...	" "	90	66.6	64.4	2970	1.39	30.75	42	13	13	36	100	.....	2.47	.....	72.9
31	"	" "	90	62.2		3250	1.63	36	39	15	16	42	100	.....	2.63	.....	74.3
28	Lincoln..........	A. W. Livingston's Sons, Columbus, O.	....	68.7	......	3100	1.41	33	40	15	16	36	100	.....	2.41	.....	74
32	Mammoth Cluster..	Plant Seed Co., St. Louis, Mo.	96	58.3	......	4015	2.15	34	42	19	19	33	100	.....	2.41	.....	72.2

YIELDS OF MIXTURES, 1894.

Pringle's progress	64.3
Early Dakota	56.9
Average	60.6
Mixture *a*	55.8
Black Russian	62.
New Dakota gray	67.3
Average	64.6
Mixture *c*	62.9
New Dakota gray	67.3
Improved American	62.1
Average	64.7
Mixture *d*	60.6
Texas red	68.2
New red rust proof	67.1
Average	67.6
Mixture	68.4
Black Russian	62.
Calgary gray	67.6
Average	64.8
Mixture	70.8
Early Dakota	56.9
Pringle's progress	64.3
Average	60.6
Mixture	61.2

Mixtures *a*, *c*, and *d* made in 1892.

YIELD OF GRAIN PER ACRE OF ELEVEN VARIETIES TESTED FOUR YEARS.

	1890		1891		1892		1894		Average.
	Rank	Bu.	Rank	Bu.	Rank	Bu.	Rank	Bu.	
Texas rust proof	1	55.9	6	72.2	9	41.2	1	74	60.8
Pringle's progress	4	48.1	2	79	2	51.3	6	64.3	60.7
New Dakota gray	8	39.4	1	85	7	41.7	3	67.3	58.3
New red rust proof	5	45	8	64.6	1	56.3	4	67.1	58.2
Texas red	2	49.7	11	60.8	8	41.7	2	68.2	55.1
Black Russian	6	40.6	7	70.8	6	44.2	9	62	54.4
American banner	10	30.6	5	73.4	3	48	5	64.4	54.1
Black prolific	9	35.9	9	68.7	5	46.6	7	64.3	53.9
Japan	7	40.3	3	75.8	10	39.1	10	60.3	53.1
Improved American	11	25.5	4	75.2	4	47.6	8	62.1	52.6
Early Dakota	3	48.8	10	63.7	11	38.2	11	56.9	51.9
Calgary gray	......	.....	......	.....	......	50.4	......	67.6	......

peat them. The general conclusions which have been drawn from these experiments may be restated almost as they were given in the bulletin reporting the experiments for 1893, as follows:

The results of the experiments with oats tried at this Station for the last seven years suggest that on the fertile soil of central eastern Illinois we may expect in a series of years an average yield an acre of a little over 50 bushels of grain and about one and one-half tons of straw, the oats weighing rather less than more than the standard weight of 32 lb.

a bushel; that it is not advisable to plow the land in the spring if the crop follows corn, the use of the disk harrow giving better results; that the seed should be sown near the last of March or first of April; that if sown broadcast it is better to sow from two and one-half to three and one-half bushels per acre, covering the seed not more than one or two inches deep; that there is no one variety greatly superior to all others, so that it is not wise to put full credence in the claims often made for new varieties; that some varieties are, however, distinctly better than some others; that neither color nor plumpness of kernels, nor weight per bushel, nor the form of the head certainly determines value; but that, generally, varieties with long, slender, comparatively light kernels have the smallest percentage of husk and, probably, the greatest feeding value; that early maturing varieties are to be preferred to those ripening later; that it is desirable to harvest the crop before it has fully ripened; and that binding and shocking the sheaves at once is an advantage rather than a disadvantage, if the grain is in fit condition for cutting.

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This Station has no seed oats for sale.

METEOROLOGICAL RECORDS.

A summary of the observation on rainfall and temperature, made at this Station for the six years ending August 31, 1894, is herewith published. This period is too short to make it safe to accept the results as fairly representing the usual climatic conditions of this region. Except for the year 1892, the rainfall has been below what has been accepted as average for central Illinois. The rainfall for the 12 months from July, 1893, to July, 1894, was remarkably small for this region—~~only 21.13~~ inches, ~~and for the following 12 months to July 1, 1894, it was~~ but 22.12 inches, ~~making the total for the two years ending June 30, 1894, but 43.25 inches~~. It should be borne in mind that the record of rainfall for a month or even a year may vary considerably at points not far apart, because of the occurrence or failure of local rains. In a series of years these differences would be equalized. The total rainfall for a year or a month does not necessarily indicate the adaptation of the season for crops, as excessively heavy rains may make the total seem satisfactory, while there may have been lack of moisture between these.

The highest temperature noted is 99 deg., in August of 1891 and 1894; the lowest—21, in January, 1894. The mean monthly temperature, during the crop growing season, has rarely varied greatly from the average for the six years, June, 1889, and September, 1891, being most striking exceptions.

RAINFALL IN INCHES AT THE ILLINOIS AGRICULTURAL EXPERIMENT STATION FOR THE SIX YEARS FROM SEPT. 1, 1888, TO AUG. 31, 1894.

	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1888	.....	.....	.....	.....	.....	.....	.....	.....	1.29	1.38	2.81	4.72	*10.20
1889	1.48	2.08	1.61	.61	5.52	6.81	5.81	.60	2.74	1.42	4.38	1.82	34.88
1890	5.26	1.87	2.70	4.11	3.56	3.80	2.83	1.93	1.19	2.35	1.63	.05	31.28
1891	.99	2.60	3.55	3.54	.89	2.08	1.41	2.86	.41	1.29	5.58	1.53	26.73
1892	.79	2.64	2.59	6.45	7.86	5.36	2.50	2.45	.93	.93	4.95	1.62	39.05
1893	1.05	4.48	3.20	7.68	4.83	1.55	.59	.06	3.62	1.14	2.98	1.09	32.27
1894	1.95	1.32	2.41	1.86	3.32	1.78	1.08	2.06	.....	.....	.....	.....	†15.79
Total	11.52	15.00	16.06	24.25	25.98	21.38	14.22	9.96	10.18	8.51	22.33	10.83	190.20
Ave..	1.92	2.50	2.67	4.04	4.33	3.56	2.37	1.66	1 69	1.42	3.72	1.80	31.70

* Four months. † Eight months.

METEOROLOGICAL RECORDS.

TEMPERATURE, DEGREES, FAHRENHEIT.—SEPT. 1, 1888, TO AUG. 31, 1894.

	January.			February.			March.			April.		
	Mean.	Max.	Min.	Mean.	Max.	Min.	Mean.	Max.	Min.	Mean.	Max.	Min.
1888	......	.....	....	......	.....	....	......	.....	....	......	.....	....
1889	29.28	57	-2	23.36	53	-7.5	39.92	72	18	51.9	75	25
1890	33.5	66	-5	34.66	68	7	33.35	61	2	52.32	81	29
1891	30.26	57	6	30.45	61	-9	32.55	65	-1	52.78	81	22
1892	19.2	57	-15	33	55	*	36.1	69	*	48.6	70.5	26
1893	14.8	48	*	25.8	51	*	37.8	76	*	49.3	75	30
1894	29.4	64	-21	24.7	53	-5	43.5	77	10	51.4	85	25
Whole period	26.07	66	*-21	28.66	68	*-9	37.20	77	*-1	51.05	85	22

	May.			June.			July.			August.		
	Mean.	Max.	Min.	Mean.	Max.	Min.	Mean.	Max.	Min.	Mean.	Max.	Min.
1888	......	.....	....	......	.....	....	......	.....	....	......	.....	....
1889	59.2	91	28	65.5	88	40	72.7	90.5	50	69.2	89	29.5
1890	58.27	87	33	74.56	96	47	73.02	97.5	45	68.74	96	44.5
1891	58.4	91	30	71.9	93	49	70.12	93	42	70.21	99	40
1892	57.9	82	36	70.6	94	51	73.3	96.5	46	71.5	94	47
1893	57.4	84	37	70.5	93	53	76.4	98	48	71.1	96	37
1894	59.6	89	32	73.4	97	34	73.8	98	47	72.3	99	41
Whole period	58.46	91	28	71.08	97	34	73.22	98	42	70.50	99	29.5

	September.			October.			November.			December.		
	Mean.	Max.	Min.	Mean.	Max.	Min.	Mean.	Max.	Min.	Mean.	Max.	Min.
1888	59.9	89	31	47.2	75	23	39.6	75	13	31.57	57	12
1889	61.32	87.5	32	47.26	82	25	36.82	62	4	42.71	66	15
1890	60.46	89	33	52.07	76	27	42.62	68	21	30.91	58	8
1891	69.2	96	41	51.3	88.5	27	35.69	67	2	37	60	11
1892	63.9	87	42	53.6	88.5	19	34.8	64	7	27.7	60	-7
1893	66.5	97	31	53.3	84	18	37.3	75	6	30	63	-6
1894	......	.....	....	......	.....	....	......	.....	....	......	.....	....
Whole period	63.54	97	31	50.78	88.5	18	37.80	75	2	33.31	66	-7

* The record is incomplete.

G. E. MORROW, A. M., *Agriculturist.*

All communications intended for the Station should be addressed, not to any person, but to the

AGRICULTURAL EXPERIMENT STATION, CHAMPAIGN, ILLINOIS.

The bulletins of the Experiment Station will be sent free of all charges to persons engaged in farming who may request that they be sent.

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WILL A. POWERS, B.S., Assistant Chemist.

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*Professor Morrow has resigned both the presidency of the Board of Direction and his position as agriculturist of the Station. Professor Burrill succeeds him as President of the Board of Direction after September 1st.

UNIVERSITY OF ILLINOIS,

Agricultural Experiment Station.

CHAMPAIGN, AUGUST, 1894.

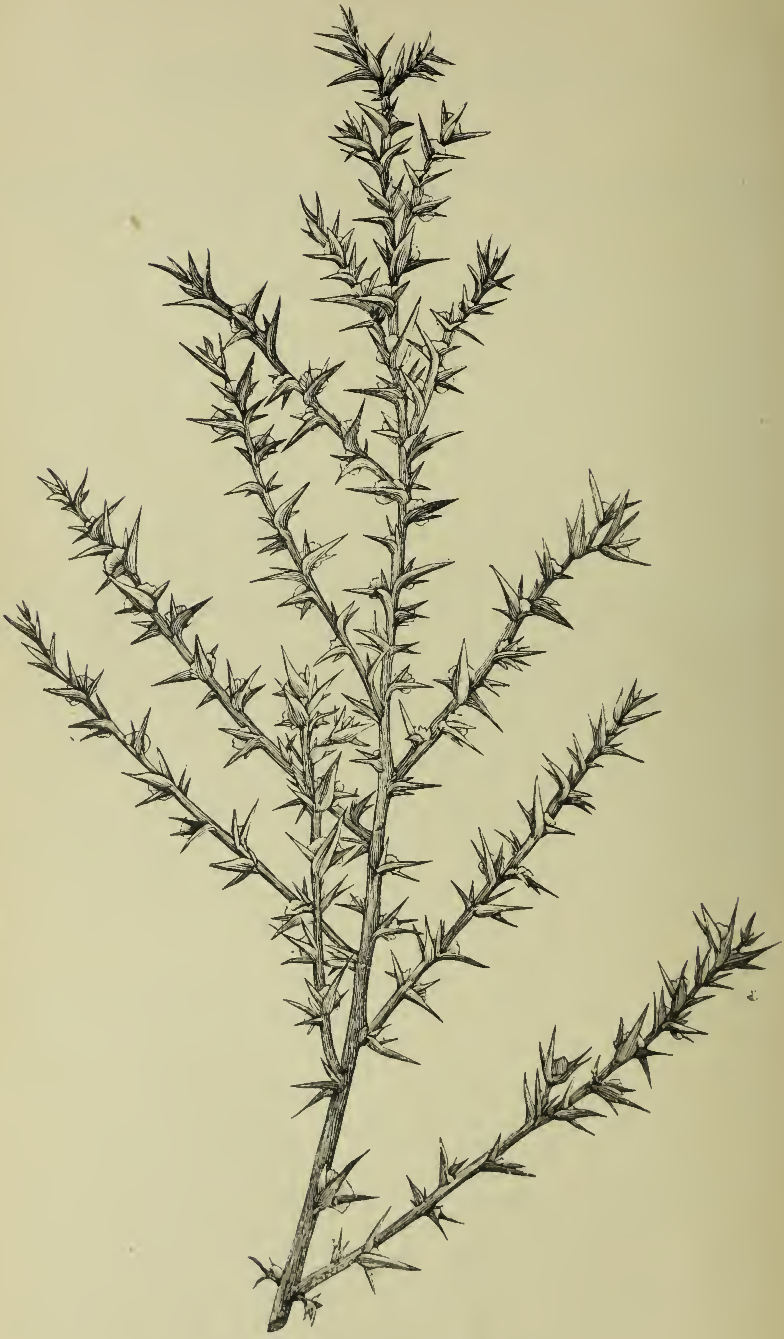
BULLETIN NO. 35.

THE RUSSIAN THISTLE IN ILLINOIS.

The Russian thistle is spreading rapidly in several of the northwestern and western states. Introduced into the southern part of South Dakota in 1873, it is now abundant over large areas in both South and North Dakota, and is also growing in different parts of Nebraska, Kansas, Minnesota, Iowa, and Wisconsin. During the present season it has been found in at least nine different places in northern Illinois and is reported to have been found in northwestern Indiana. George P. Clinton, Assistant Botanist to this Station, seems to have been first to recognize the weed growing in this state, at Polo. It is quite probable that a few plants are growing in other places in the states last named, as railway transportation of live stock, grains, or other farm seeds, or hay from the infested regions affords a ready means for the distribution of the seeds of this and other weeds.

While there is reason to believe this weed might not become so serious a pest in Illinois as it is in the Dakotas, even if allowed to become common, it is exceedingly important that this result be prevented, and this can be done. There is little reason to believe that there is any great number of plants now growing in any part of the state. They are, usually, of such size and appearance that they can easily be seen. The plant is an annual. When pulled or cut at this season it dies soon.

This Station has received specimens of the weed found growing at nine different points in the northern part of Illinois: Chicago, St. Charles, Hampshire, Davis Junction, Polo, Savanna, Oregon, Nachusa, and Peotone. The specimen from Chicago was found on waste ground near the lake shore; that from St. Charles was from waste land near a foundry receiving material from the northwest; all the others from railway embankments or along their right of way. These facts suggest that in



Russian Thistle—A Branch.

and about Chicago, Peoria, and other cities with large railroad traffic from the northwest, along railroad lines, especially in the northern part of the state, on the roadside and waste land near these railways, and about establishments handling material from the northwestern states are the places where this weed will most probably be found. But any farmer who has purchased grain, grass, flax, or other seeds may have the weed growing on his farm.

This bulletin is designed to urge the importance of farmers, road commissioners, and railway agents and section men looking for and destroying the weed wherever found, and to enable those not familiar with it to recognize it.

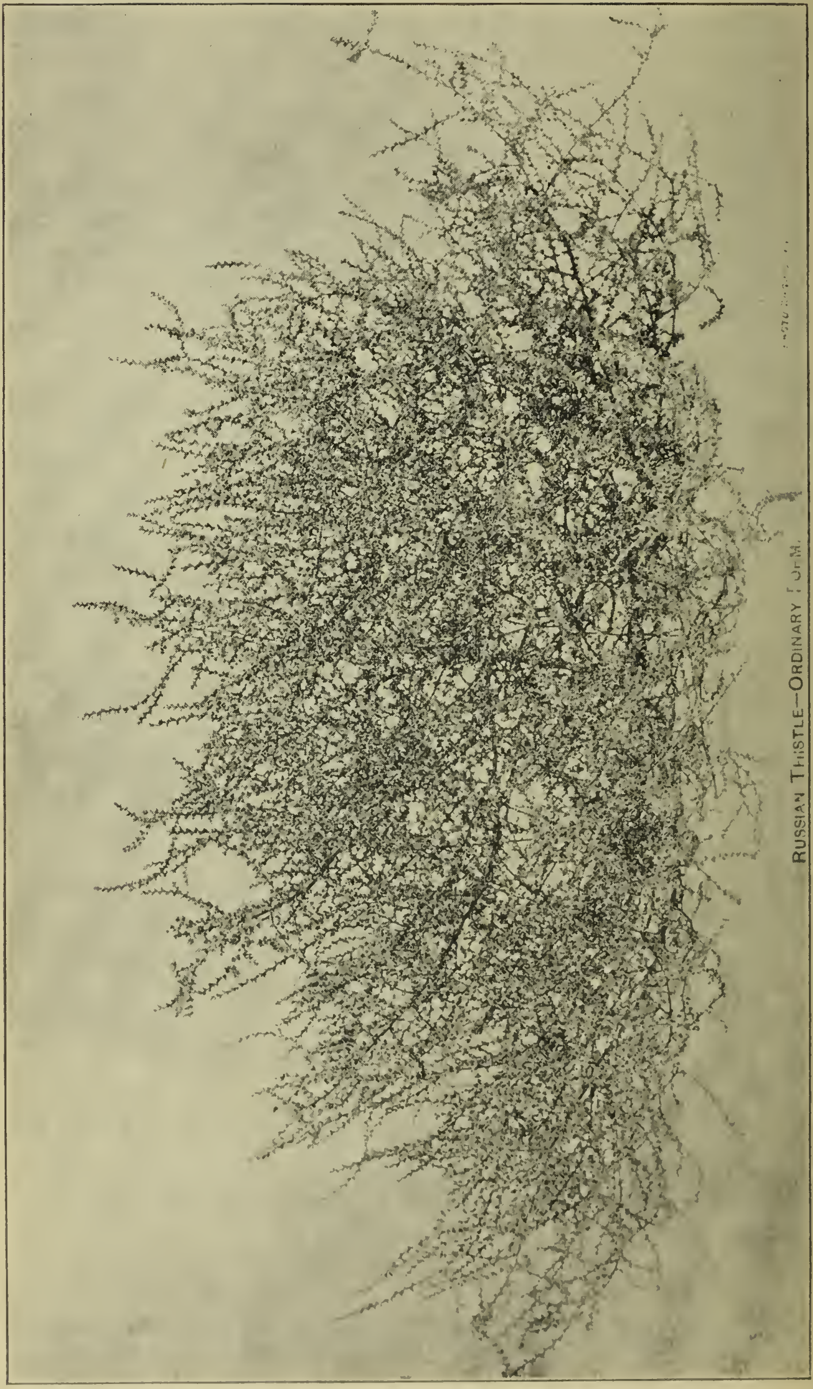
The U. S. Department of Agriculture has published a valuable bulletin (No. 15, Division of Botany) giving a full discussion of the history, distribution and means for eradicating the weed. This bulletin can be obtained by applying to the Department at Washington. It is illustrated with good pictures of the plant. Two of these have been reproduced for this bulletin; one a picture of an average plant at or near maturity. This picture was made from a photograph taken by the Wisconsin Station of a plant found growing on a railroad embankment not far from Madison. The other picture is of a branch of a plant showing form and size of leaves. Comparison of any suspected plant with these pictures will enable any one to identify this weed.

The plant is not a thistle, and does not look like one. Russian tumble weed would have been an appropriate name. The plant much resembles the common tumble weeds of the west. When mature the stems are more woody; the spines or little thorns are hard. Sometimes the plants are very compact, nearly round. Sometimes when growing close together they fail to have the rounded form. They may be one, two, or three feet high, and from eighteen inches to six feet across. The leaves are very small, as are the flowers and seeds. At this season and later the stems have a purple or rose color. After September 1st the seeds may be sufficiently mature to grow. If the seeds are formed, the plants should be burned as soon as dry. Left to themselves they do not usually break off and roll or tumble until after hard freezing. It has been estimated that an average sized plant may have 20,000 to 30,000 seeds, and it may carry these long distances.

It is suggested that where plants are found before the seeds have formed, one or more specimens, plainly labeled, be placed where they may readily be seen by parties interested, who may thus learn to recognize them. It is also suggested that it is always safe to destroy any weed, even though it be not recognized as an especially troublesome pest.

This Station will identify weed specimens sent to it, but it is urged that their destruction should not be delayed for such identification.

G. E Morrow, *Agriculturist.*



RUSSIAN THISTLE—ORDINARY FORM.

UNIVERSITY OF ILLINOIS.

Agricultural Experiment Station.

URBANA, AUGUST, 1894.

BULLETIN NO 36.

CONTENTS.

Stock Feeding in Illinois.
Index to Bulletins, No. 17-36.

STOCK FEEDING IN ILLINOIS.

Illinois has long been one of the chief stock breeding and feeding states of the Union. The condition of the cattle breeding and feeding industry of the state has been unsatisfactory for nearly a decade of years. Prices for both pure bred and fat cattle have greatly declined, and while they have temporarily advanced at times, the range of prices for several years past, has been such as to give little or no profit to breeders and feeders as a class. During this time there has been a notable advance in the price of farm land over much of the state, with a corresponding increase in its rental value. While there has been increased attention to the dairy interests of the state, there has been a large decline in the beef cattle breeding and feeding. The number of herds of pure bred beef cattle in the state has decreased, as has the number of cows kept for rearing cattle for fattening. Especially in the great feeding regions of central Illinois, large areas of fine pasture lands have been plowed up and devoted to grain growing.

The conditions surrounding hog breeding and feeding have been more favorable. There have been marked fluctuations in price, but as a whole, a fair margin of proof has been secured by careful breeders and feeders. The present interest in both branches of the business, is perhaps as great as at any former time.

Sheep breeding, during several recent years, was perhaps the most profitable branch of animal industry for many Illinois farmers. Increasing numbers of sheep were brought from ranches and ranges of the further west for feeding in the state. Within the last two years, however, there has been a great decline in prices of sheep and wool of all grades, and there is much discouragement among both breeders and feeders.

The widely extended and unusually severe drought of the present summer will have on all branches of the live stock industry, far reaching effects, some of which it is impossible to predict. The lessened aggregate yields of almost all the stock food crops of the country, almost certainly insures fairly high prices for these for the present season, and probably for another year, so far as corn at least is concerned. Wheat is a marked exception in price to the other grain crops. There seems little reason to anticipate any considerable increase in price for this grain in the near future, and already there is large use of wheat as a food for farm animals. The lessened supply and higher price of food in several of the great stock states of the west will tend to increase the number of cattle, hogs, and sheep forwarded to the market, or for feeding in Illinois. It is probable that the effect may be favorable to Illinois breeders and feeders for a few years to come.

Especially in cattle and sheep feeding it is obvious that only the wisest economy can give a satisfactory profit to the Illinois feeders. Economy of production is vastly more important than possibilities of production. An attempt may be made to secure the lessened cost of production, by a reduction of the quantity or cost of the food, land, or labor used.

PRACTICE OF ILLINOIS STOCK FEEDERS.

A record of the practice of experienced and intelligent farmers is invaluable in any discussion of best methods of stock feeding. To secure such a record of practice in Illinois 250 circular letters, containing a series of questions concerning opinions and practice in feeding cattle, hogs, and sheep, were sent to as many farmers in the state. The list of names was made up by the assistance of members of the Board of Direction of this Station, and of the State Board of Agriculture. Answers were received from 108 men, well representing the different classes of stockmen of the state. A few are well known breeders of pure bred stock; some fatten large numbers, others but few animals; some rear all their feeding stock, others buy all or a part. Nearly all parts of the state, except the extreme south, are represented. It is believed very few, if any, of those who sent answers represent any unusual conditions or practice, except in minor particulars.

Of the 108 reporting, 86 feed cattle, 102 hogs, and 44 sheep. Thirty-four report concerning all three classes of stock; 49 concerning cattle and hogs; 13 on hogs alone; three on sheep alone. These figures well illustrate the facts that hog feeding almost invariably accompanies cattle feeding in Illinois, and that sheep are kept by only a minority of Illinois farmers. Only about one-third of the replies contained reports on sheep; several reports stating that the writers had never owned a sheep.

Much most valuable information was obtained from the replies to the questions sent out; but it is difficult to tabulate this information as some of the questions were somewhat general, and not all were answered directly.

Cattle Feeding.

Of the cattle feeders 62 name Shorthorns as the breed preferred or handled; seven name Herefords, six Angus, and one Galloway, as first choice. In a majority of cases it is evident that pure bred cattle are not referred to. In a good number of cases, where a preference is mentioned, it is coupled with statement showing that other classes are handled from necessity. Several reports mention "Durhams" instead of the more usual name Shorthorn. A few dairy farmers reported on hog feeding, but their answers concerning cattle are not included.

Of 77 feeders answering the question, 22 rear the cattle they feed, 27 buy them, and 28 do both.

Of 72 feeders, 26 believe grain feeding to young steers on good pasture is profitable. Several limit their approval of the practice to cases where it is expected to sell the steers within a few months.

Of 83 feeders, 23 make no provision for extra food for grazing cattle in case of drouth, aside from aiming not fully to stock the pastures; 22 reserve a special pasture, and 38 feed grain or hay—usually green corn.

There is a wide divergence of opinion as to age of steers preferred for full grain feeding. Of 80 feeders answering, six name under two years, 11 two years, nine between two and three years, 36 three years, 10 between three and four years, six four years, and two give five years as maximum age. Obviously, making "baby beef" has not become a common practice in Illinois, while it is equally obvious that feeding cattle of four years or greater age is much less common than was the case some years ago.

There is also wide difference in practice as to time when full feeding is begun. Four feeders advise continous full feeding from birth of the calf. The practice of others is influenced by the fact that they buy the cattle they feed. Each of the four seasons and almost every month of the year are specified by different feeders. The fall months seem most in favor; next the winter or very early spring.

In response to the question "How long is it profitable to continue full feeding?" the answers are somewhat indefinite. Several feeders reply, "'till the cattle are fat"; others that the state of the market determines time of sale; 45 say from three to six months, five, three months or less, and six over six months, one of these giving twelve months as maximum.

Corn is the great food used in fattening cattle, aside from grass and clover. Seventy-eight feeders specify corn, 21 of these naming shock corn; five name oats, four oil meal or cake, and one glucose meal. Twenty name hay, most frequently clover hay, and a very few name straw.

As to methods of preparation, six feeders mention grinding corn, 25 either break, chop, split, or crush the ears, and nine use shelled corn.

As to frequency of feeding, nine feeders name once, 48 twice, four three times, and one, five times a day.

Fifty-five feeders pronounce stable or stall feeding unprofitable, while eleven think the practice profitable. Fifty-two name sheds, four barns, and ten straw stack, hedges, or timber as shelter given their cattle.

Four feeders only state that they have used ensilage, and one of these says, "very little." Of those who refer to time of cutting corn for fodder most prefer cutting at a rather early stage of maturity.

Ten feeders indicate that bran, middlings, oil meal, etc., are used by them; 42 state that they do not use them, or to a very limmited extent. The form of the question makes it probable that those who made no reply do not use these foods for fattening cattle.

Fifty-five feeders practice dehorning, many of them indicating their belief in the decided value of the practice; 19 do not practice dehorning and some of these are strongly opposed to the practice. Presumably, those not answering do not dehorn their cattle.

Feeders generally attach high value to the droppings of the cattle as food for hogs. Several state that without the use of this there is no profit in feeding. One thinks there is little value in the droppings where ground feed is used for the cattle. Nine feeders estimate the value of this offal at 50 per cent of the value of the corn fed; five at 33 per cent, and nine at 20 to 35 per cent. One places the value at eight to ten cents per bushel of corn fed; one at three or four lb. pork per bushel fed; one at 30 to 40 lb. pork per month. The number of hogs allowed to follow a given number of steers varies, generally from one to two per steer, depending on size of hogs, rate of feeding and time of year. In a number of cases the brood sows with their litters of pigs are kept with the cattle in the pastures.

HOG FEEDING.

Hogs are bred and fed on most Illinois farms. Of the 108 farmers responding to the circular sent out, 102 make report as to hogs, although only 13 reported on hogs alone.

The Poland China and Berkshire seem to be sweepingly preferred among breeds—78 naming the Poland China and 21 the Berkshire as breed preferred. Ten of the latter name some other breeds also. Six prefer the Duroc Jersey, two the Chester white, one the Yorkshire, and eight specify some cross. In many cases grades or crosses of the breed preferred are named as well as the pure bred stock. Only three prefer white breeds.

There is a difference of opinion as to the best season at which to have pigs farrowed, but the majority specify April or May; 25 like March pigs, and 17 name the fall months; six name February.

Concerning no question were more diverse answers received than that asking information as to methods of feeding and managing suckling pigs. Twenty-nine reports state that no other attention is given than allowing the sows to run on pasture or follow cattle. Of the others some feed corn in various forms, some oats, wheat, bran, middlings, oil meal, rye, and milk in various combinations.

Forty-one feeders believe full grain feeding of pigs is desirable during the summer; 52 believe this is not desirable.

As to pasturage preferred, 51 name clover first or alone; 16, clover and blue grass; seven, clover and timothy; and six, clover and rye.

Where the hogs do not get their food entirely from the pastures and the droppings of the cattle, corn is the almost exclusive food for fattening hogs, and this is generally fed in the ear. Twenty-five soak corn, five mention grinding it, and two speak of cooking food for fattening hogs. Thirty-eight state their opinion that neither grinding soaking nor cooking corn for hogs is profitable. Seventeen report having fed wheat, generally with good satisfaction, only two pronouncing it unsatisfactory. (These answers were given last spring.)

Thirteen feeders believe fattening hogs are not better for exercise; eight think they should have a little exercise; most allow them to take exercise somewhat freely.

Sixteen feeders prefer selling when pigs are eight months old or less—only one naming a less age than six months; 42 name eight to 12 months, and nine prefer over 12 months, 24 being maximum.

Ten feeders prefer selling at weight of 200 lb. or less, 150 lb. being minimum; 15 at from 200 to 250 lb.; 26 at 250 to 300 lb.; and 14 at greater weight than 300 lb.; two naming 500 lb. as maximum.

SHEEP FEEDING.

Of the 44 farmers reporting their experience in sheep feeding, 18 name the Shropshire, seven the Southdown, six "Downs", five the Oxfordshire Down, one the Hampshire Down, four the Cotswold, one the Lincoln, two the Merino, and five different cross bred sheep as favorite breed—in some cases naming more than one.

As to time at which it is preferred to have lambs dropped, 14 name February, 16 March, and 22 April, three naming January and a like number May, and one December. Evidently raising especially early lambs is not a common practice in Illinois.

Thirty-two feeders say they feed ewes and suckling lambs grain, naming corn, oats, wheat and wheat screenings, and bran. Five do not feed grain in fattening sheep, 23 feed corn, 26 oats, six wheat or wheat screenings, two bran, and four oil meal in various combinations. Ten have fed wheat at some time, two of these reporting poor results. Seven report their belief that it is profitable to grind grains for sheep.

Twenty-four keep fattening sheep in sheds, seven in barns, and one reports "timber" as the shelter given.

Full feeding of sheep is not continued so long as with either cattle or hogs. Six feeders name two months or less; nine three months and seven three or four months.

NOTES BY FEEDERS.

A few feeders added statements in addition to answering the questions, or made such statements instead of answering the questions as put. Among these was the well known firm of Shorthorn breeders and cattle feeders, James N. Brown's Sons, of Berlin, Sangamon Co., who wrote:

"....We buy our cattle for fattening and of as good grade as we can secure. We mainly fatten them on blue grass. We buy them in the fall; carry them on rich stalk fields until February or March, and then feed them with corn in the ear on blue grass pastures, generally quitting feeding corn May 10th. We market them in August. We do not handle hogs with them. We would not handle cattle at all, if we did not have the blue grass pastures, as prices the past few years and now, would not pay for fattening them on corn. Men who make beef on corn or dry feed, cannot make money on cattle at present prices."

J. P. Henderson, Virden, Ills., wrote:

"I became tired of the cattle business some four years since, and sold off almost everything in that line, only keeping a few thoroughbred Herefords for fun, and one or two Jerseys for family butter. I am renting out my old pastures for corn, where they have been grazed for over 30 years. I have watched with a great deal of interest, the results of the new methods of feeding and caring for stock, and have never been able to figure out a profit in them, unless indeed, a man were made of some indestructible material and could do all the work himself. The world is all trying to go too fast—feeding cattle at yearlings, and pigs from the day they can open their eyes. We must give them some time to grow and make a frame and then it is easy to put flesh on it. The stalk must grow before the ear is formed."

Benj. Whitsitt, Preemption, wrote:

"In this age of overproduction and low prices, if the feeder expects to place anything on the side of profit, he must feed a limited number of the very best animals and give them the best of care."

James A. Perry, Wilmington, after expressing his decided preference for Hereford cattle, wrote:

"I no not think it profitable to feed cattle in pasture, if there is plenty of good water. For many years I have found it very profitable to put in a good piece of sowed corn for feeding in a dry time. As to the age of cattle for feeding, I find it all depends on the make up of the cattle, as some are better feeders at two years old than are some at four years, even if of the same breed. In general early feeding is the most profitable. The quicker you can mature an animal the more money it will give you. It is not profitable to feed after your cattle are ripe and ready for market. I have made cattle gain five and one-half pounds per day for 60 days, but after that not nearly that average. I have had much more success in feeding ground feed than I have ever had in any other way, and I have tried almost every way and have come to the conclusion, that to grind corn and cob together, rather fine, is much better than to feed clear meal. I have never had so good results as when I have fed five times per day, but I never feed so the cattle leave the least bit in their feed boxes. Cattle will not eat any more when fed five times a day, than when fed all they will eat at three times, but the advantage is that you do not overload their stomachs and therefore the food is more easily digested and they fatten faster on the same food. I have had better success in feeding cattle kept in their stalls than in any other way of keeping them. I am a great advocate of feeding bran and middlings, and think they are nearly, or quite as good as the same weight of corn. My experience in feeding oil meal is limited. I am greatly in favor of dehorning cattle, as you can feed them in a much smaller space and they will do much better."

Thomas Clark, Beecher, a very successful breeder of Hereford cattle wrote that he thinks it is profitable to feed young steers on pasture if they are to be turned off before they are two years old as he would prefer, commencing full feeding in the spring when they are yearlings, feeding either shelled corn or ground corn and oats, twice a day. He uses a little oil meal for young stock. He does not think stall feeding profitable for a bunch of steers, preferring an open shed with an enclosed yard for winter.

Among the few who use oil meal for fattening cattle to any considerable extent, is O. W. Hoit, Geneseo, who wrote:

"I like to give cattle about five pounds of oil meal each per day. I have fed it on pasture without corn ten pounds per day and made well by it, but consider $25 a ton high with corn at 30 cents a bushel."

F. O. Lash, Hendrix, wrote:

"I believe the farm should be made to produce all the feed needed for the stock, with the exception of middlings, bran, and oil meal, except in times like the present when wheat is cheaper than middlings; but experience has convinced me that much more attention should be paid to the cultivation of beets, mangels, etc."

Thos. N. Thornburg, postoffice not stated, wrote that he feeds 150 to 200 cattle a year, buying them of all the beef breeds. He has cattle on full feed all the year, selling when the market suits, usually feeding from five to seven months, according to the flesh when he commences. Sometimes he buys half fat cattle. He believes it more profitable to handle two or three lots of cattle per year than only one. He tries to avoid selling in the fall in competition with the rush of· western cattle, also in March and April.

CONCLUSIONS FROM EXPERIMENTS.

Experiments in feeding cattle and hogs have been continuously in progress at this Station since it was established. Comparatively few of the results have been published because of the belief that in an unusual degree the value of the results of such experiments increases, not only with the number of trials made, but with the number of years during which the experiments are continued, and that the publication of the results of one or a few experiments might readily lead to wrong conclusions. There are many disturbing conditions in experiments with soils and plants, but the number of such conditions is still greater in the case of animals. The peculiarities of different animals, and the variations in seasons, sometimes in the quality and condition of foods supposed to be practically identical, often greatly affect results. There are also great practical difficulties in determining accurately the gain in weight, especially in cattle feeding, or in feeding trials for short periods, or where there is a marked change in the character of the food given. The marked variations in the weight of animals, especially cattle, in a single day, even when the weighings are made as nearly as possible under like conditions show the experimenter that the apparent results may not represent the true gain or loss, even when the trial has been continued for a considerable time.

Without attempting to give details of experiments tried, some conclusions based upon the study of them while in progress, and since their completion, will be stated, special reference being had to conditions in central Illinois.

It is almost never profitable to attempt to produce the greatest possible quantity of either weight or fat with any animal. To keep either steer or hog until it has reached its largest possible size, or to feed either until it has reached the practical limit of increase of fat, is almost certainly unprofitable.

Economy of prodution will be best secured by attempts to reduce to a reasonable minimum the land used, the cost of the food, and of the labor employed, rather than by giving attention to any one of these points alone. Home grown foods are to be used as the chief reliance. The by-products of oil mills, glucose, starch manufactories, or of distilleries may often be employed with profit, but usually only as supplemental to the main feeding ration. The exceptions to this rule may be found in the case of farmers who can procure the by-products at little cost for transportation. Good grass and clover grazed by the animal is the cheapest food for the production of either beef or mutton. Indian corn at customary prices, is the cheapest grain food for fattening any class of farm animals, and in the large majority of cases may wisely form a part of the grain ration of young animals. Oats are an extremely valuable food, but, one year with another, the price of this grain is such as to make it unprofitable to use it as the exclusive or chief food for farm animals. The value of wheat as food for farm stock, is not yet fully determined. At present prices, it may more profitably be fed than sold, but it is confidently believed that, in the great corn growing region of the state, at least, it cannot be so cheaply raised as can an equal food value in Indian corn. The stover of Indian corn, clover hay, and oat straw, with possibly soy beans, and cow peas, and in exceptional cases millets grown as catch crops, should take the place of timothy or other ordinary grass hay, in horse, cattle, and sheep feeding.

Under conditions available for most Illinois farmers, it is impossible to feed stock as economically during either winter or extreme heat of summer, as in the spring or fall. The increased price secured, may often justify feeding during the winter. Grain feeding during the summer is often necessary in the usual cattle feeding system.

Comparatively simple methods of feeding are as yet wisest for the average stock feeder. This applies both to methods of shelter and caring for the animal, and to the preparation of the food. The weight of evidence, both by general practice and by experiments tried elsewhere, is so strongly against the profitableness of cooking food, under ordinary conditions in Illinois, that no experiments in this line have been tried at this Station.

Grinding grain frequently gives a profit. This is especially true where the small grains are to be fed. The evidence is conclusive that feeding unground wheat to either cattle or hogs is a wasteful method, as a considerable percentage passes through the animals undigested. If impracticable to grind it, soaking is advisable. These statements also apply to rye and oats. On the other hand, grinding corn to be fed either to fattening cattle or to hogs is not generally profitable for Illinois farmers. In a majority of cases the animals can grind it more cheaply than can the farmer. Crushing the corn, especially where the ears are large, more generally seems profitable in cattle feeding. Soaking the corn when fed after it has become thoroughly dry is believed profitable. It is assumed that hogs "follow the cattle" when they are fed unground corn; otherwise there is much waste.

Outdoor feeding of cattle is more profitable in good weather than is stall feeding. It is not so clearly proved but is believed that good sheds are a more profitable shelter for steers than the stable.

The old practice of keeping a cow simply to rear calves is no longer profitable. If cattle of equal quality could be secured, "stockers" or "feeders" could be more profitably bought than raised by central Illinos feeders.

The direct increase of weight almost never repays the cost of full grain feeding of cattle, at prices which have prevailed for some years past. Profit must come, if at all, from increase of value of the whole carcass. This should be at least one cent a pound. The value of the pork made from the offal and the value of the manure must also be counted. Grain feeding to young steers on good pasture is not believed to be directly profitable during the best of the grazing season, but in each of the last six years there have been times when such feeding was profitable. Some experiments indicate that it is more profitable to give full rather than partial grain rations to such cattle. In each of six years past the rate of gain of steers even with abundance of grass has greatly lessened on the approach of hot weather, generally about June 20th, and the full rate was not regained until September. It again declined with the approach of cold weather.

Trials for six years indicate that an acre of good "blue grass pasture" in central Illinois will support a steer weighing 800 to 1000 lbs.

during the grazing season, but not allow much, if any, increase. In years of summer drouth extra feed has had to be supplied. Grain fed steers have been kept on one-third less acreage in about the same condition.

Experience during the present and recent dry summers strongly emphasizes the chief weakness of blue grass—its almost entire failure to grow during dry weather. Orchard grass has been found best of the ordinary grasses in this respect, but the common red clover has shown its superiority to any of the smaller grasses for either hay or grazing in dry years. Highly prized as are the old blue grass pastures, it seems clearly proved that a greater quantity of food would be produced by putting them under a rotation, with corn and clover the chief crops. This would involve more labor, but in present conditions would give better prospect of profits.

There is constantly increasing evidence of the great value of corn stover as food for cattle, sheep, and horses and that it may wisely be substituted for a large part of the timothy hay fed farm animals. There are practical difficulties in saving and handling it. While ensilage is largely fed to dairy cows it is little used for fattening cattle. Experiments at this and other stations show that the largest food value per acre is produced, in ordinary seasons, by planting corn more thickly than is the common practice. This reduces the size of the ears and thus removes one objection to feeding ear corn. In many cases it is better to feed the corn without husking. There are a number of feed cutters which satisfactorily cut stalk and ear. Shredding the stalks is preferable to cutting. The cut stover or fodder may be safely stored in barns or sheds in dry seasons, but there is danger of injury if the weather be wet so as to prevent thorough drying. The corn may be shelled and the stalks put in good condition for feed with an ordinary threshing machine.

Several trials show that the quantity of both corn and stover increases until the plant is quite well matured. Early cutting involves a loss. Leaving the corn uncut until fully mature increases danger of loss by storms, the blowing of leaves, etc. Exposure in the fields in shocks very perceptibly lessens the value of the stover. Whatever the method of preparation or class of stock fed it is rarely wise to compel them to eat all the stover of the large varieties of corn mainly grown in Illinois. Twenty to twenty-five per cent need not be considered a large amount for refuse, which may be used for litter or as an absorbent of the liquid manure.

No more rapid or satisfactory gains have been secured in cattle feeding than where steers have been fed the maturing corn in the pastures in September and October, until the stalks had fully matured, they being fed with the ears.

The time for the profitable production of "baby beef" proper has not yet come in Illinois. Usually steers may most profitably be marketed when between two and three years old, if grown by the feeder.

Hog feeding is often directly profitable. No grain has been found superior to corn as a fattening food for hogs. In a majority of experiments tried, a rate of gain of over 10 lb. pork to one bushel of corn has been gained. Where hogs are too long confined to a corn diet alone, or have grown very fat, or are fed in bad weather, the rate of gain often falls far below this. Wheat has not, in trials at the Station, been shown better than corn, pound for pound. There has been noticeable loss when fed unground, either dry or soaked. Pigs have preferred the corn when this has been fed mixed with wheat.

Grass and clover are highly desirable for growing pigs and in early stages of fattening. Their value, however, seems to be more in the way of maintaining health and giving pleasant variety of food than in causing direct increase in weight. It is not profitable to compel hogs to make grass or clover their only food at any stage of their growth.

The evidence in favor of full feeding from birth to time of slaughter seems more conclusive in the case of hogs than with cattle. The market preference as to age and weight changes frequently, but generally it is not desirable to keep hogs until they are more than a year old. The cheapest gain in weight is usually during the pleasant weather in autumn, when the hogs are fed on new crop corn, but prices are usually lowest at this season.

Experience at the Station shows that it is often better to sell hogs in small lots to butchers or shippers than to keep the entire lot until all are fully fat. In some cases this is true with cattle. Fully fattened animals are kept at a loss.

G. E. Morrow, A. M.,
Agriculturist.

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*Professor Morrow has resigned both the presidency of the Board of Direction and his position as agriculturist of the Station. Professor Burrill succeeds him as President of the Board of Direction after September 1st.

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